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Economic Impact Analysis of Effluent Limitations and Standards for the Nonferrous Metals Manufacturing Industry, Phase 1

Policy Planning and Evaluation, Inc., McLean, VA

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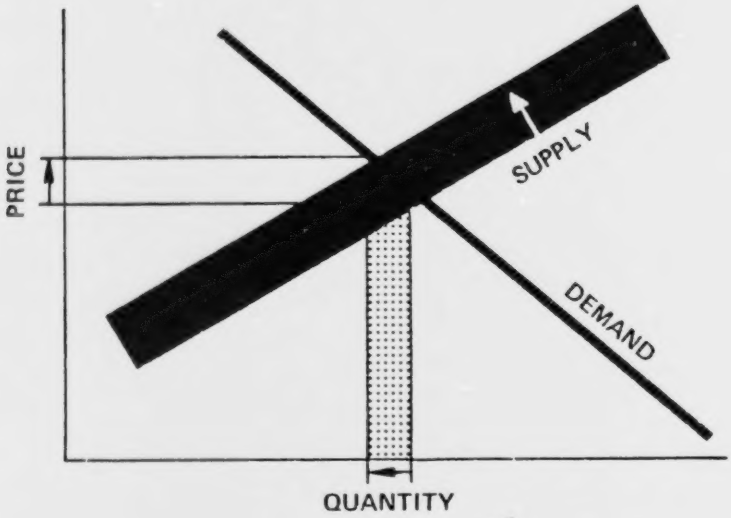

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The U.S. Environmental Protection Agency issued effluent limitations guidelines and standards for the Nonferrous Metals Manufacturing Industry in February 1984. This report estimates the economic impact of pollution control costs in terms of price changes, effects on profitability, continued viability of plants, and other effects. A plant-specific approach is used to assess these impacts for ten metal subcategories, which comprise one phase of this industry. For most of these subcategories, the impacts are expected to be minimal.

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ECONOMIC IMPACT ANALYSIS
OF EFFLUENT LIMITATIONS AND STANDARDS
FOR THE NONFERROUS METALS
MANUFACTURING INDUSTRY
(PHASE I)

Submitted to:

U.S. Environmental Protection Agency
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Submitted by:

Policy Planning & Evaluation, Inc.
8301 Greensboro Dr., Suite 460
McLean, VA 22102

February 1984

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

This document is an economic impact assessment of the recently-issued effluent guidelines. The report is being distributed to EPA Regional Offices and state pollution control agencies and directed to the staff responsible for writing industrial discharge permits. The report includes detailed information on the costs and economic impacts of various treatment technologies. It should be helpful to the permit writer in evaluating the economic impacts on an industrial facility that must comply with BAT limitations or water quality standards.

The report is also being distributed to EPA Regional Libraries, and copies are available from the National Technical Information Service (NTIS), 5282 Port Royal Road, Springfield, Virginia 22161 (703/487-4600).

If you have any questions about this report, or if you would like additional information on the economic impact of the regulation, please contact the Economic Analysis Staff in the Office of Water Regulations and Standards at EPA Headquarters:

401 M Street, S.W. (WH-586)
Washington, D.C. 20460
(202) 382-5397

The staff economist for this project is Debra Maness (202/382-5385).

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This document is a contractor's study prepared for the Office of Water Regulations and Standards of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impact which could result from the application of effluent standards and limitations issued under Sections 301, 304, 306, and 307 of the Clean Water Act to the Nonferrous Metals Manufacturing Industry (Phase I).

The study supplements the technical study (EPA Development Document) supporting the issuance of these regulations. The Development Document surveys existing and potential waste treatment control methods and technologies within particular industrial source categories and supports certain standards and limitations based upon an analysis of the feasibility of these standards in accordance with the requirements of the Clean Water Act. Presented in the Development Document are the investment and operating costs associated with various control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the application of various control methods and technologies. This study investigates the impact on product price increases, the continued viability of affected plants, employment, and foreign trade.

This study has been prepared with the supervision and review of the Office of Water Regulations and Standards of EPA. This report was submitted in fulfillment of EPA Contract No. 68-01-6731 by Policy Planning & Evaluation, Inc. This analysis was completed in February 1984.

TABLE OF CONTENTS

Page No.

EXECUTIVE SUMMARY 1

I. INTRODUCTION

A. Purpose and Scope I-1

B. Industry Characteristics I-2

C. Approach I-2
  1. Methodology I-2
  2. Effluent Limitation Guidelines I-3

D. Organization of the Report I-3

II. ECONOMIC IMPACT ANALYSIS METHODOLOGY

A. Overview II-1

B. Step 1: Description of Production Technology II-3

C. Step 2: Description of Structure of the Industry II-3

D. Step 3: Factors Affecting Demand II-4

E. Step 4: Trends and Projections in Prices and Capacity Utilization and Consideration of Baseline Population II-4

F. Step 5: Compliance Cost Estimates II-5

G. Step 6: Plant-Level Economic Impacts II-6
  1. Description of Screening Analysis II-6
  2. Discussion of Plant Closure Tests II-7
    a. Net Present Value Test II-7
    b. The Liquidity Test II-9
    c. Interpretation of Plant Closure Tests II-9

H. Step 7: Industry-Wide Impacts II-10
  1. Changes in the Cost of Production II-10
  2. Price Changes II-10
  3. Changes in Return on Investment II-10
  4. Effects on Capital Expenditures II-10
  5. Employment Impacts II-11
  6. Effects on the Balance of Trade II-11

I. Step 8: New Source Impacts II-11

J. Step 9: Small Business Analysis II-11

TABLE OF CONTENTS (Continued)

Page No.

III. PRIMARY ALUMINUM

A. Introduction III-1

B. Technology III-1

C. Industry Structure III-2
    1. Overview III-2
    2. Primary Aluminum Smelters III-2

D. Aluminum Demand III-7
    1. Construction Industry III-7
    2. Transportation III-7
    3. Cans and Containers III-10
    4. Electrical III-10
    5. Appliances and Equipment III-10
    6. Other Uses III-10

E. Current Trends -- Capacity Utilization and Prices III-10

F. Estimates of Prices and Capacity Utilization III-11

G. Effluent Control Guidelines and Costs III-11
    1. Regulatory Alternatives III-11
    2. Costs for Existing Plants III-14

H. Economic Impact Analysis III-14
    1. Screening Analysis III-14
    2. Other Impacts III-14
        a. Increase in Cost of Production III-14
        b. Price Change III-16
        c. Change in Return on Investment III-16
        d. Capital Impacts III-16
        e. Employment Impacts III-17
        f. Foreign Trade Impacts III-17

IV. PRIMARY COPPER

A. Introduction IV-1

B. Technology IV-1

C. Industry Structure IV-1
    1. Overview IV-1
    2. Primary Copper Smelters and Refineries IV-2
    3. Description of Plants IV-2

D. Primary Copper Demand IV-2

E. Current Trends -- Capacity Utilization and Prices IV-7

TABLE OF CONTENTS (Continued)

Page No.

F. Estimates of Prices and Capacity Utilization IV-9

G. Effluent Control Guidelines and Costs IV-12
  1. Regulatory Alternatives IV-12
  2. Costs for Existing Plants IV-12

H. Economic Impact Analysis IV-12
  1. Screening Analysis IV-12
  2. Plant Closure Analysis IV-14
  3. Other Impacts IV-14
    a. Increase in Cost of Production IV-14
    b. Price Change IV-15
    c. Change in Return on Investment IV-15
    d. Capital Impacts IV-15
    e. Employment Impacts IV-16
    f. Foreign Trade Impacts IV-16

V. PRIMARY LEAD

A. Introduction V-1

B. Technology V-1

C. Industry Structure V-2
  1. Overview V-2
  2. Primary Smelting and Refining Plants V-5
  3. Description of Plants V-5

D. Lead Demand V-7
  1. Batteries V-7
  2. Chemicals V-7
  3. Pigments V-7
  4. Ammunition V-7
  5. Other Metal Products V-9
  6. Miscellaneous V-9

E. Current Trends -- Capacity Utilization and Prices V-9

F. Estimates of Prices and Capacity Utilization V-9

G. Effluent Control Guidelines and Costs V-11
  1. Regulatory Alternatives V-11
  2. Costs for Existing Plants V-11

TABLE OF CONTENTS (Continued)

Page No.

H. Economic Impact Analysis V-11
  1. Screening Analysis V-11
  2. Other Impacts V-14
    a. Increase in Cost of Production V-14
    b. Price Change V-15
    c. Change in Return on Investment V-15
    d. Capital Impacts V-16
    e. Employment Impacts V-16
    f. Foreign Trade Impacts V-16

VI. PRIMARY ZINC

A. Introduction VI-1

B. Technology VI-1

C. Industry Structure VI-2
  1. Overview VI-2
  2. Domestic Smelters VI-2

D. Zinc Demand VI-2
  1. Galvanized Steel VI-2
  2. Die Castings VI-6
  3. Brass and Bronze VI-6
  4. Zinc Oxide VI-6
  5. Other Uses VI-6

E. Current Trends -- Capacity Utilization and Prices VI-6

F. Estimates of Prices and Capacity Utilization VI-7

G. Effluent Control Guidelines and Costs VI-10
  1. Regulatory Alternatives VI-10
  2. Costs for Existing Plants VI-10

H. Economic Impact Analysis VI-10
  1. Screening Analysis VI-10
  2. Other Impacts VI-12
    a. Increase in Cost of Production VI-12
    b. Price Change VI-12
    c. Change in Return on Investment VI-13
    d. Capital Impacts VI-13
    e. Employment Impacts VI-13
    f. Foreign Trade Impacts VI-14

TABLE OF CONTENTS (Continued)

Page No.

VII. SECONDARY ALUMINUM

A. Introduction VII-1

B. Technology VII-1

C. Industry Structure VII-2
  1. Overview VII-2
  2. Description of Plants VII-2

D. Aluminum Demand VII-5

E. Current Trends -- Capacity Utilization and Prices VII-5

F. Estimates of Prices and Capacity Utilization VII-5

G. Effluent Control Guidelines and Costs VII-8
  1. Regulatory Alternatives VII-8
  2. Costs for Existing Plants VII-8

H. Economic Impact Analysis VII-8
  1. Screening Analysis VII-8
  2. Plant Closure Analysis VII-8
  3. Other Impacts VII-10
    a. Increase in Cost of Production VII-10
    b. Price Change VII-10
    c. Change in Return on Investment VII-11
    d. Capital Impacts VII-11
    e. Employment Impacts VII-12
    f. Foreign Trade Impacts VII-12

VIII. SECONDARY COPPER

A. Introduction VIII-1

B. Technology VIII-1
  1. Refined Unalloyed Copper VIII-1
  2. Brass and Bronze Alloys VIII-1

C. Industry Structure VIII-2
  1. Overview VIII-2
  2. Secondary Smelters and Refineries VIII-2
  3. Description of Plants VIII-5

D. Secondary Copper Demand VIII-5

E. Current Trends -- Capacity Utilization and Prices VIII-7

F. Estimates of Prices and Capacity Utilization VIII-7

TABLE OF CONTENTS (Continued)

Page No.

G. Effluent Control Guidelines and Costs VIII-10
  1. Regulatory Alternatives VIII-10
  2. Costs for Existing Plants VIII-10

H. Economic Impact Results VIII-10
  1. Screening Analysis VIII-10
  2. Other Impacts VIII-10
    a. Increase in Cost of Production VIII-12
    b. Price Change VIII-12
    c. Change in Return on Investment VIII-12
    d. Capital Impacts VIII-13
    e. Employment Impacts VIII-13
    f. Foreign Trade Impacts VIII-13

IX. SECONDARY LEAD

A. Introduction IX-1

B. Technology IX-1

C. Industry Structure IX-2
  1. Overview IX-2
  2. Secondary Smelters IX-5
    a. Integrated Battery Producers IX-5
    b. Large Secondary Smelting Companies IX-5
    c. Small Independents and Integrated Battery Producers ... IX-5
    d. Recyclers/Remelters IX-6

D. Lead Demand IX-6

E. Current Trends -- Capacity Utilization and Prices IX-6

F. Estimates of Prices and Capacity Utilization IX-7

G. Effluent Control Guidelines and Costs IX-7
  1. Regulatory Alternatives IX-7
  2. Costs for Existing Plants IX-7

H. Economic Impact Analysis IX-11
  1. Screening Analysis IX-11
  2. Plant Closure Analysis IX-11
  3. Other Impacts IX-12
    a. Increase in Cost of Production IX-12
    b. Price Change IX-12
    c. Change in Return on Investment IX-13
    d. Capital Impacts IX-13
    e. Employment Impacts IX-13
    f. Foreign Trade Impacts IX-14

TABLE OF CONTENTS (Continued)

Page No.

X. SECONDARY SILVER

A. Introduction X-1

B. Technology X-1

C. Industry Structure X-2
  1. Overview X-2
  2. Description of Plants X-6

D. Secondary Silver Demand X-6
  1. Photography X-6
  2. Electrical and Electronic Components X-6
  3. Electroplated Ware, Sterlingware, Jewelry and Arts X-6
  4. Brazing Alloys and Solders X-8
  5. Other X-8

E. Current Trends -- Capacity Utilization and Prices X-8

F. Estimates of Prices and Capacity Utilization X-8

G. Effluent Control Guidelines and Costs X-9
  1. Regulatory Alternatives X-9
  2. Costs for Existing Plants X-12

H. Economic Impact Analysis X-12
  1. Screening Analysis X-12
  2. Closure Analysis X-12
  3. Other Impacts X-15
    a. Increase in Cost of Production X-15
    b. Price Change X-16
    c. Change in Return on Investment X-16
    d. Capital Impacts X-16
    e. Employment Impacts X-17
    f. Foreign Trade Impacts X-17

XI. PRIMARY COLUMBIUM/TANTALUM

A. Introduction XI-1

B. Technology XI-1
  1. Columbium XI-1
  2. Tantalum XI-2

TABLE OF CONTENTS (Continued)

Page No.

C. Industry Structure XI-3
  1. Columbium XI-3
    a. Overview XI-3
    b. Description of Plants XI-3
  2. Tantalum XI-5
    a. Overview XI-5
    b. Description of Plants XI-8

D. Demand XI-8
  1. Columbium XI-8
    a. Construction XI-8
    b. Machinery XI-8
    c. Oil and Gas XI-11
    d. Transportation XI-11
    e. Other XI-11
  2. Tantalum XI-11
    a. Electronics XI-11
    b. Metal-Working Machinery XI-11
    c. Transportation XI-13
    e. Other XI-13

E. Current Trends -- Capacity Utilization and Prices XI-13
  1. Columbium XI-13
  2. Tantalum XI-13

F. Estimates of Prices and Capacity Utilization XI-14

G. Effluent Control Guidelines and Costs XI-16
  1. Regulatory Alternatives XI-16
  2. Costs for Existing Plants XI-16

H. Economic Impact Analysis XI-16
  1. Screening Analysis XI-16
  2. Plant Closure Analysis XI-16
  3. Other Impacts XI-18
    a. Increase in Cost of Production XI-18
    b. Price Change XI-18
    c. Change in Return on Investment XI-19
    d. Capital Impacts XI-19
    e. Employment Impacts XI-20
    f. Foreign Trade Impacts XI-20

XII. PRIMARY TUNGSTEN

A. Introduction XII-1

B. Technology XII-1

TABLE OF CONTENTS (Continued)

Page No.

C. Industry Structure XII-1
  1. Overview XII-1
  2. Description of Plants XII-2

D. Tungsten Demand XII-2
  1. Metal-Working, Mining, and Construction Machinery XII-2
  2. Transportation XII-5
  3. Lamps and Lighting XII-5
  4. Electrical XII-5
  5. Other Uses XII-5

E. Current Trends -- Capacity Utilization and Prices XII-5

F. Estimates of Prices and Capacity Utilization XII-6

G. Effluent Control Guidelines and Costs XII-9
  1. Regulatory Alternatives XII-9
  2. Costs for Existing Plants XII-9

H. Economic Impact Analysis XII-9
  1. Screening Analysis XII-9
  2. Plant Closure Analysis XII-9
  3. Other Impacts XII-11
    a. Increase in Cost of Production XII-11
    b. Price Change XII-11
    c. Change in Return on Investment XII-12
    d. Capital Impacts XII-12
    e. Employment Impacts XII-13
    f. Foreign Trade Impacts XII-13

XIII. NEW SOURCE IMPACTS XIII-1

XIV. SMALL BUSINESS ANALYSIS XIV-1

XV. LIMITATIONS OF THE ANALYSIS XV-1

A. Data Limitations XV-1

B. Methodology Limitation XV-2

C. Sensitivity Analysis XV-2
  1. Compliance Costs XV-2
  2. Sludge Disposal Costs XV-3
  3. Prices XV-3
  4. Sludge Disposal and Prices in Secondary Lead XV-3
  5. Profit Margins for Secondary Producers XV-4

TABLE OF CONTENTS (Continued)

Page No.

BIBLIOGRAPHY

APPENDIX A: DESCRIPTION OF THE NPV TEST AND ITS SIMPLIFICATION A-1

APPENDIX B: IMPLEMENTATION OF THE NPV TEST B-1

APPENDIX C: CALCULATION OF TOTAL ANNUAL COSTS FOR THE TWO CLOSURE ANALYSIS TESTS C-1

APPENDIX D: PROCEDURE FOR CALCULATING INDUSTRY-WIDE IMPACTS D-1

LIST OF TABLES

Page No.

1 Compliance Costs for the Nonferrous Metals Manufacturing Industry 5

2 Results of the Screening and Plant Closure Analyses for the Nonferrous Metals Manufacturing Industry 6

3 Summary of Other Impacts 8

III-1 World Aluminum Industry, 1982 .... III-3

III-2 U.S. Production, Imports, and Exports III-4

III-3 Aluminum Ingot Production Capacity III-5

III-4 U.S. Aluminum Consumption III-8

III-5 U.S. Aluminum Demand by End Use III-9

III-6 U.S. Aluminum Prices III-12

III-7 Primary Aluminum Production and Capacity III-13

III-8 Primary Aluminum -- Compliance Cost Estimates III-15

IV-1 World Copper Industry -- 1982 .... IV-3

IV-2 U.S. Imports and Exports of Refined Copper IV-4

IV-3 Primary Copper Industry -- Plants and Locations IV-5

IV-4 Consumption of Copper Products by Industry, 1982 .... IV-6

IV-5 U.S. Demand by End Use IV-8

IV-6 Average Annual U.S. Producer Copper Price IV-10

IV-7 Capacity Utilization Rates for U.S. Smelters and Refineries IV-11

IV-8 Primary Copper -- Compliance Cost Estimates IV-13

V-1 World Lead Industry -- 1982 .... V-3

V-2 U.S. Imports and Exports of Primary Lead V-4

V-3 Lead Smelters/Refiners -- 1982 .... V-6

V-4 Lead Consumption in the United States by End-Use Markets .. V-8

V-5 Average Annual U.S. Producer Price of Lead V-10

V-6 Primary Lead Industry - Capacity Utilization V-12

V-7 Primary Lead -- Compliance Cost Estimates V-13

VI-1 U.S. Imports and Exports of Zinc VI-3

VI-2 Primary Zinc Smelters -- 1982 .... VI-4

VI-3 1982 U.S. Slab Zinc Consumption by End Use VI-5

VI-4 Average Annual U.S. Producer Price of Zinc VI-8

LIST OF TABLES (Continued)

		Page No.
VI-5	Capacity Utilization Rates for Domestic Primary Producers	VI-9
VI-6	Primary Zinc -- Compliance Cost Estimates	VI-11
VII-1	U.S. Primary and Secondary Aluminum Production	VII-3
VII-2	U.S. Imports and Exports of Aluminum Scrap	VII-4
VII-3	U.S. Aluminum Prices	VII-6
VII-4	Capacity Utilization Rates	VII-7
VII-5	Secondary Aluminum — Compliance Cost Estimates	VII-9
VIII-1	Domestic Copper Recovery from Scrap	VIII-3
VIII-2	U.S. Imports and Exports of Copper-Base Scrap	VIII-4
VIII-3	Domestic Consumption of Copper Scrap	VIII-6
VIII-4	Average Annual U.S. Producer Copper Price	VIII-8
VIII-5	Secondary Copper Production and Capacity	VIII-9
VIII-6	Secondary Copper -- Compliance Cost Estimates	VIII-11
IX-1	U.S. Primary and Secondary Lead Production	IX-3
IX-2	U.S. Exports of Lead Scrap	IX-4
IX-3	Average Annual U.S. Producer Price of Lead	IX-8
IX-4	Secondary Lead Production and Capacity	IX-9
IX-5	Secondary Lead Compliance Cost Estimates	IX-10
X-1	U.S. Refined Silver Production by Source	X-3
X-2	Refined Silver Production by Ownership of Source Materials	X-4
X-3	U.S. Imports and Exports of Refined Silver	X-5
X-4	U.S. Silver Consumption by End Use	X-7
X-5	U.S. Silver Prices	X-10
X-6	Secondary Silver Capacity Utilization Rates	X-11
X-7	Secondary Silver -- Compliance Cost Estimates	X-13
X-8	Secondary Silver -- Summary of Potential Closures	X-14
XI-1	U.S. Imports and Exports of Columbium	XI-4
XI-2	Major U.S. Columbium Processing and Producing Companies - 1982	XI-6
XI-3	U.S. Imports and Exports of Tantalum	XI-7
XI-4	Major U.S. Tantalum Processing and Producing Companies	XI-9
XI-5	U.S. Columbium Demand Pattern	XI-10
XI-6	U.S. Tantalum Consumption by End Use	XI-12

LIST OF TABLES (Continued)

Page No.

XI-7 U.S. Columbium and Tantalum Prices XI-15

XI-8 Primary Columbium/Tantalum -- Compliance Cost Estimates ... XI-17

XII-1 U.S. Tungsten Imports and Exports XII-3

XII-2 Major U.S. Tungsten Producers XII-4

XII-3 U.S. Tungsten Prices XII-7

XII-4 Primary Tungsten Production and Capacity XII-8

XII-5 Primary Tungsten -- Compliance Cost Estimates XII-10

XIV-1 Annual Compliance Costs as a Percent of Annual Revenues for Large and Small Plants XIV-4

XIV-2 Annual Compliance Costs as a Percent of Total Production Cost for Small Plants XIV-5

B-1 Values for Group Ratios B-10

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

A. PURPOSE

This study assesses the economic impacts likely to result from the effluent guidelines, limitations, and standards applicable to the nonferrous metals smelting and refining industry. These regulations are based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES), which are being issued under authority of Sections 301, 304, 306, and 307 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977. The economic impacts have been evaluated for specific regulatory options that correspond to varying levels of effluent controls. The approach consists of two parts:

- assessing the potential for plant closures; and
- determining the general industry-wide impacts, including changes in prices, employment, rates of return on investment, balance of trade, and small business impacts.

This economic analysis revises and updates the analysis issued with the proposed regulations.

B. INDUSTRY COVERAGE

For purposes of this study, ten nonferrous metal smelting and refining industries are considered. These industries and the number of plants, by discharge status, covered by this regulation are listed below.

Metal	Number of Plants Incurring Costs	
	Direct	Indirect
Primary Aluminum	24	0
Primary Copper	3	0
Primary Lead	4	2
Primary Zinc	4	1
Secondary Aluminum	9	15
Secondary Copper	0	6
Secondary Lead	8	25
Secondary Silver	6	26
Primary Columbium/ Tantalum	3	2
Primary Tungsten	4	6

Primary operations reduce metal ores to metal and metal products. Secondary operations convert scrap and waste to useful metal and metal products. Primary and secondary operations are treated separately in the analysis. Operating and financial conditions are calculated independently for each of the ten metal processes.

C. METHODOLOGY

The following paragraphs describe the steps followed in the analysis to evaluate the potential economic impacts of each regulatory option as of the effective date of compliance, estimated to be in 1985. The methodology has been consistently applied to all metal types.

1. Description of the Industry

The first step in the analysis is to develop a description of the industry as it currently exists. The analysis of the current conditions addresses the following areas:

- technology;
- industry structure;
- demand for the metal products; and
- current trends in prices and capacity utilization.

This information forms the basis for conducting financial tests and analyzing the potential for plant closures. Basic industry information was obtained from the Department of the Interior's Bureau of Mines, trade associations, and contacts with industry representatives.

2. Industry's Baseline Conditions in 1985

Plants subject to this regulation will be required to install the necessary control equipment by 1985. It is expected that the current economic recovery will continue, even if at a slow pace, and that the general economic conditions in 1985 will be somewhat better than those in 1982, but not as good as those at the peak of 1978-1979. Since 1985 will be neither a "boom" nor a "bust" year, it is reasonable to assume that: (1) most plants will operate at less than full capacity (this implies that companies will not add new capacity to their operations); and (2) plants that survived the 1982 recession will be operating in 1985. Hence, this study assumes that the plant population and the total capacity in an industry segment in 1985 will remain the same as it was in 1982.

3. Costs of Compliance

The water treatment control systems, costs, and effluent limitations and pretreatment standards recommended for the nonferrous smelting and refining industry are discussed in a separate document. Comprehensive descriptions of the methodology, the recommended technologies, and the estimated costs are provided in the Development Document for Effluent Limitations Guidelines and Standards for the Nonferrous Metals Point Source Category (Development Document). Several treatment and control options based on BPT, BAT, NSPS, PSES, and PSNS for facilities within the industry are considered. The engineering estimates of costs for the pollution control options are used to form the basis for the economic impact analysis.

4. Plant Closure Analysis

It is assumed that plants incurring small compliance costs will not be forced to close. Therefore, the closure analysis is conducted in two steps. First, a screening analysis is conducted to identify plants that clearly will not be affected by this regulation. Second, a net present value test and a liquidity test are carried out for those plants that fail the screen.

a. Screening Analysis

Total annual compliance cost as a percentage of annual revenues is used as the screening criterion. The threshold value chosen for the screen is 1.0 percent. If compliance costs for the plant are less than 1.0 percent of plant revenues, the plant is not considered highly affected, and is not analyzed further.

b. Closure Analysis

Pollution control expenditures will result in reduction of income when costs cannot be passed through. These expenditures may create a permanent change in income levels and thereby reduce average income in the future. The expenditures may also adversely affect a plant's short-term cash flow. The consideration of cash flow becomes important when a plant is already in poor financial health. These long-term and short-term effects of pollution control expenditures are analyzed by conducting a net present value (NPV) test and a liquidity test. The NPV test is used to determine the long-term viability of a plant; the liquidity test addresses potential short-term cash flow problems.

5. Other Impacts

In addition to closures, other industry-wide impacts are assessed. These include:

- increase in cost of production;
- price change (note that this varies from the closure analysis which assumes that costs may not be recovered through increased prices);
- change in return on investment;
- capital compliance costs compared to annual capital expenditures (capital impacts);
- employment impacts; and
- foreign trade impacts.

In addition, a separate analysis is performed for the small businesses affected by the imposition of compliance costs.

D. BASIS FOR COMPLIANCE COSTS

Brief descriptions of the various treatment options are listed below. These descriptions do not necessarily correspond to the specific options considered for a particular metal. A complete description of the options can be found in the Development Document.

- Option A - This option includes equalization, chemical precipitation, and sedimentation ("lime and settle").
- Option B - This option includes Option A plus flow reduction before lime and settle.
- Option C - This option includes Option B plus multimedia filtration of the final effluent. For some metals, this option also includes sulfide precipitation.
- Option E - (Primary Aluminum only) This option includes Option C plus activated carbon adsorption of the final effluent when organics are present.
- Option G - (Secondary Copper only) This option includes the treatment cited for Option A, but also includes flow reduction of casting water via a cooling tower or holding tank and 100 percent recycle of all treated water to reuse in the plant.

Not all options were considered for each metal type. The costs estimated for each metal type are presented in Table 1. Costs were calculated for each plant based on production, wastewater flows, and treatment in place. All costs are in 1982 dollars. Investment costs in Table 1 represent the total capital necessary to construct the treatment facilities. Total annual costs are comprised of annual operating and maintenance costs plus the annualized portion of the investment costs.

E. FINDINGS

1. Screening and Plant Closure Analyses

The overall results of the screening and plant closure analyses are presented in Table 2. For most metals, no more than one plant at any option level violates the screening test (annual cost greater than 1 percent of revenues). The exceptions are Primary Columbium/Tantalum, Secondary Lead, and Secondary Silver. For Primary Columbium/Tantalum one plant fails the screening test at Options A and B, and three fail at Option C. For Secondary Lead, five plants at Options A and B, and six plants at Option C fail the screen. For Secondary Silver there are nine screen failures at each option.

TABLE 1

COMPLIANCE COSTS FOR THE NONFERROUS METALS MANUFACTURING INDUSTRY

(1982 dollars)

	Option A		Option B		Option C		Option E		Option G	
	Annual[a]	Investment	Annual[a]	Investment	Annual[a]	Investment	Annual[a]	Investment	Annual[a]	Investment
Primary Aluminum										
Direct			6,562,660	14,642,552	7,065,909	16,095,317	8,791,478	23,519,110		
Primary Copper										
Direct			446,276	816,570	696,422	1,763,257				
Primary Lead										
Direct	55,611	211,199	96,863	349,799	240,407	759,549				
Indirect	4,574	37,950	4,574	37,950	4,574	37,950				
Primary Zinc										
Direct			103,717	265,512	446,120	1,352,998				
Indirect			15,697	18,975	93,358	283,250				
Secondary Aluminum										
Direct			355,587	1,044,691	382,028	1,132,453				
Indirect			801,471	2,110,210	853,191	2,263,521				
Secondary Copper										
Indirect									159,945	654,085
Secondary Lead										
Direct	683,930	1,631,023	683,930	1,631,023	749,958	1,861,336				
Indirect	1,344,922	3,694,375	1,347,558	3,718,300	1,507,926	4,256,883				
Secondary Silver										
Direct	210,806	110,411	210,806	110,411	275,501	277,611				
Indirect	286,710	564,840	291,121	576,561	316,915	629,739				
Primary Columbium/ Tantalum										
Direct	777,295	679,524	790,994	736,174	824,567	829,674				
Indirect	475,139	950,837	481,232	979,299	501,115	1,034,849				
Primary Tungsten										
Direct	636,932	642,262	637,998	646,799	684,031	773,436				
Indirect	281,139	503,660	281,139	503,660	307,811	567,599				

SOURCE: U.S., Environmental Protection Agency.

[a] Annual costs include operating and maintenance costs plus annualized investment costs.

TABLE 2

RESULTS OF THE SCREENING AND PLANT CLOSURE ANALYSES FOR THE NONFERROUS METALS MANUFACTURING INDUSTRY

	Option A		Option B		Option C		Option E		Option G	
	Failed Screen	Potential Closures	Failed Screen	Potential Closures	Failed Screen	Potential Closures	Failed Screen	Potential Closures	Failed Screen	Potential Closures
Primary Aluminum										
Direct			0	0	0	0	0	0		
Primary Copper										
Direct			1	0	1	0				
Primary Lead										
Direct	0	0	0	0	0	0				
Indirect	0	0	0	0	0	0				
Primary Zinc										
Direct			0	0	0	0				
Indirect			0	0	0	0				
Secondary Aluminum										
Direct			0	0	0	0				
Indirect			1	0	1	0				
Secondary Copper										
Indirect									0	0
Secondary Lead										
Direct	1	0	1	0	2	0				
Indirect	4	0	4	0	4	0				
Secondary Silver										
Direct	2	1	2	1	2	1				
Indirect	7	6[a]	7	6[a]	7	6[a]				
Primary Columbium/ Tantalum										
Direct	1	0	1	0	3	0				
Indirect	0	0	0	0	0	0				
Primary Tungsten										
Direct	1	0	1	0	1	0				
Indirect	1	0	1	0	1	0				

SOURCE: Policy Planning & Evaluation, Inc. estimates.

[a] Represents one plant and five production lines.

Of the plants discussed above which were selected for further analysis, application of the NPV and liquidity closure tests identified potential closures in only one metal type -- Secondary Silver. For each option, two plants and five secondary silver product lines did not pass the closure tests.

2. Other Impacts

a. Increase in Cost of Production

The increase in cost of production is measured by expressing annual compliance costs as a percentage of total production costs. This figure represents the incremental increase to production costs associated with each treatment option. The results, which are generally less than 1 percent, are found in Table 3.

b. Price Change

Price change is measured by annual compliance costs expressed as a percentage of revenues. In contrast to the screening and closure analyses, in which no costs are assumed to be passed through to consumers, the computation of price change assumes that all costs of compliance are passed through to consumers. The impact represents the maximum increase in price expected under this assumption. Price impacts are presented in Table 3 and in most cases are small.

c. Change in Return on Investment

This impact represents the change in earnings per dollar of assets that plants will face under each treatment option. These results are summarized in Table 3. The results range from a decrease of less than 1 percent for Primary Lead to no more than 18 percent for Primary Columbium/Tantalum.

d. Capital Impacts

Investment compliance costs are expressed as a percentage of estimated average capital expenditure. The capital impact is the amount of additional capital expenditure needed by plants to comply with each treatment option while maintaining their previous investment programs. Results are found in Table 3. For the most part, the ratio of investment costs to average annual expenditures is under 20 percent. The maximum ratio value is 37 percent, for Secondary Silver.

e. Employment Impacts

Employment impacts are measured by the total number of jobs lost at plants expected to close. For Secondary Silver, two plants and five lines identified as potential closures for Option C are small operations. The total number of jobs lost is estimated to be 62.

This figure represents total employment at the plant, and therefore overstates the potential number of job losses because only the

TABLE 3

SUMMARY OF OTHER IMPACTS

(percent)

	Increase in Cost of Production	Price Change	Change in Return on Investment	Capital Impacts
Primary Aluminum				
Direct				
Option B	0.12	0.11	-1.89	2.15
Option C	0.13	0.12	-2.04	2.36
Option E	0.17	0.15	-2.62	3.45
Primary Copper				
Direct				
Option B	0.08	0.07	-1.11	1.07
Option C	0.12	0.11	-1.84	2.31
Primary Lead				
Direct				
Option A	0.01	0.01	-0.23	0.39
Option B	0.02	0.02	-0.40	0.65
Option C	0.06	0.05	-0.95	1.42
Indirect				
Option A	--[a]	--	-0.10	0.29
Option B	--	--	-0.10	0.29
Option C	--	--	-0.10	0.29
Primary Zinc				
Direct				
Option B	0.06	0.06	-0.98	1.24
Option C	0.27	0.25	-4.34	6.33
Indirect				
Option B	0.04	0.04	-0.54	0.36
Option C	0.23	0.21	-3.70	5.40
Secondary Aluminum				
Direct				
Option B	0.09	0.09	-3.57	7.86
Option C	0.10	0.09	-3.83	8.52
Indirect				
Option B	0.20	0.20	-7.96	15.95
Option C	0.23	0.21	-8.48	17.11

(Continued)

TABLE 3 (Continued)

	Increase in Cost of Production	Price Change	Change in Return on Investment	Capital Impacts
Secondary Copper				
Direct				
Option G	0.07	0.06	-2.73	8.04
Secondary Lead				
Direct				
Option A	0.40	0.39	-15.38	28.34
Option B	0.40	0.39	-15.38	28.34
Option C	0.44	0.43	-16.90	32.34
Indirect				
Option A	0.31	0.30	-12.16	25.42
Option B	0.31	0.30	-12.19	25.59
Option C	0.35	0.34	-13.64	29.29
Secondary Silver				
Direct				
Option A	0.04	0.04	-0.44	1.93
Option B	0.04	0.04	-0.44	1.93
Option C	0.05	0.05	-0.62	4.85
Indirect				
Option A	0.19	0.17	-2.57	33.48
Option B	0.19	0.17	-2.61	34.18
Option C	0.21	0.19	-2.84	37.33
Primary Columbium/ Tantalum				
Direct				
Option A	1.41	1.29	-17.11	25.03
Option B	1.44	1.32	-17.52	27.12
Option C	1.50	1.37	-18.41	30.57
Indirect				
Option A	0.69	0.63	-9.65	27.82
Option B	0.70	0.64	-9.80	28.65
Option C	0.72	0.66	-10.23	30.28
Primary Tungsten				
Direct				
Option A	1.05	0.90	-7.17	10.03
Option B	1.05	0.90	-7.19	10.10
Option C	1.13	0.97	-7.80	12.08
Indirect				
Option A	0.43	0.36	-3.20	7.21
Option B	0.43	0.36	-3.20	7.21
Option C	0.47	0.40	-3.52	8.13

SOURCE: Policy Planning & Evaluation, Inc. estimates.

[a] Less than 0.01.

silver product line has been identified as a potential closure. The impacts on the communities where these plants are located will be minimal since the plants and lines are spread across the country and in any given area represent a small portion of the total community employment.

f. Foreign Trade Impacts

The economic impact of this regulation on foreign trade is the combined effect of price pressure from higher costs and production loss due to potential plant closure. Because minimal price impacts are expected even if compliance costs are passed through, no significant foreign trade impact is forecast. Additionally, potential plant closures in the Secondary Silver industry are not expected to affect foreign trade because these closure candidates represent only a small fraction of total industry production.

3. Small Business Impacts

Small business impacts are analyzed using two tests: (1) total annual compliance costs as a percentage of total revenues; and (2) compliance investment cost as a percentage of average capital expenditures. The results show that a substantial number of small businesses are not significantly affected by this regulation.

4. New Source Impacts

The basis for new source performance standards (NSPS) and pretreatment standards for new sources (PSNS) as established under Section 306 of the Clean Water Act is the best available demonstrated technology. For regulatory purposes new sources include greenfield plants and major modifications to existing plants.

In evaluating the potential economic impact of the NSPS/PSNS regulations on new sources, it is necessary to consider the costs of the regulations relative to the costs incurred by existing sources under the BAT/PSES regulations.

The Agency has determined that the new source regulations are not significantly more costly than those for existing sources. The technology basis of the new source regulations is the same as for BAT but with additional flow reduction for some subcategories. There is no incremental cost associated with these additional flow reductions, however, and new sources will therefore not be operating at a cost disadvantage relative to existing sources due to the regulations.

CHAPTER I

INTRODUCTION

I. INTRODUCTION

A. PURPOSE AND SCOPE

This study assesses the economic impacts likely to result from the imposition of effluent guidelines, limitations, and standards on plants engaged in the smelting and refining of the following nonferrous metals:

- Primary Aluminum
- Primary Copper
- Primary Lead
- Primary Zinc
- Secondary Aluminum
- Secondary Copper
- Secondary Lead
- Secondary Silver
- Primary Columbium/Tantalum, and
- Primary Tungsten

These subcategory designations do not precisely correspond to the list of technical subcategories in the actual regulation. Primary copper plants covered by this regulation operate smelters, refineries, and acid plants. For purposes of this economic impact analysis, these facilities are included in the same subcategory. The primary lead and zinc subcategories will be treated similarly. The technical analysis on which the regulation is based addresses smelters, refineries, and acid plants separately.

This study represents a revision to the economic impact analysis issued with the proposed regulation. The Agency received many significant comments that addressed the economic and financial assumptions used in the proposed document. Of particular concern is the fact that the previous analysis does not account for the 1982 recession and the accompanying setbacks experienced by many firms in prices, capacity utilization, and profits. Certain assumptions made in the analysis at proposal predicted that industry shipments would grow steadily from 1978 to 1985, that plants would run at close to capacity, and that compliance costs could be passed through to customers in the form of higher costs. The methodology developed for this analysis responds to the concerns expressed about these assumptions. For example, in this study, financial conditions in 1985 are derived from data that include the 1982 downturn. Also, plants are not expected to run at full capacity. This study also assumes that price increases which pass through costs are impractical due to the competitive nature of the metals markets.

Of the plants in the U.S. that smelt and refine the nonferrous metals listed above, only those that discharge wastewater and will incur compliance costs are analyzed in this study. Analysis results are presented separately for direct and indirect (those that discharge to publicly-owned treatment works) dischargers.

Compliance costs are developed for each discharging plant, taking into account production levels, wastewater flows, and treatment equipment already in place. Technical information on smelting and refining plants was collected from a survey of the industry conducted under the authority of Section 308 of the Clean Water Act; however, only a limited amount of this data was appropriate for use in this economic analysis. Therefore, industry-level information available from public sources and the business segment data included in corporate annual reports were used in the economic analysis to augment plant-level information.

B. INDUSTRY CHARACTERISTICS

All metals segments, with the exceptions of Primary Columbium and Tantalum, are treated separately for purposes of this analysis. Because columbium and tantalum are generally produced together at most plants, compliance costs for the total operation have been estimated. Primary production of lead, copper, and aluminum are considered apart from the production of these metals by secondary plants. Industry characteristics and financial conditions have been derived separately for primary and secondary producers, taking into account the distinct difference in raw materials and processes. However, with respect to demand and prices, the primary and secondary industries compete in similar markets and, therefore, have been treated similarly.

C. APPROACH

This study begins with a discussion of the methodology developed to perform the economic impact and plant closure analyses. Research of existing financial analysis literature suggests that cash flow analysis is the most appropriate method of predicting financial distress and closure. Hence, net present value and liquidity tests based on cash flows are performed for each plant expected to experience significant compliance costs. The methodology is then applied to each metal type, allowing for differences in the financial conditions of metal groups. For example, key industry-level financial ratios used in the analysis have been calculated separately for primary and secondary producers; alloy and metal powder producers; and producers of precious and non-precious metals. Finally the results of the economic analysis are presented, including a discussion of the various impacts of factors such as the cost of production, prices, employment, and foreign trade.

1. Methodology

The methodology for this analysis involves two major steps. First, a screening analysis is performed to determine those plants for which the regulatory compliance costs will clearly not be significant. Second, for those plants expected to incur significant costs of compliance, two closure tests are performed. These tests, the net present value test and the liquidity test, assess long-term and short-term viability, respectively. The impacts on the cost of production, prices, rate of return on investment, capital expenditures, employment, and foreign trade are predicted by calculating a variety of ratios and reviewing pertinent summary statistics.

2. Effluent Limitation Guidelines

The effluent limitation regulations covered by this analysis include:

- Effluent limitations based on the Best Practicable Control Technology Currently Available (BPT) to be met by existing industrial dischargers;
- Effluent limitations based on the Best Available Technology Economically Achievable (BAT) to be met by existing industrial dischargers;
- New Source Performance Standards (NSPS) based on the Best Available Demonstrated Technology to be met by new source industrial dischargers;
- Pretreatment Standards for Existing Sources (PSES) for existing dischargers to publicly-owned treatment works; and
- Pretreatment Standards for New Sources (PSNS) for new dischargers to publicly-owned treatment works.

D. ORGANIZATION OF THE REPORT

Chapter II presents the methodology employed for this economic impact analysis. The analysis for each nonferrous metal is presented in Chapters III through XII. Each of these chapters includes a discussion of the technology, the structure of the industry, current trends in capacity and prices, projections of prices and capacity utilization, costs of effluent control, and the economic impact analysis. Chapters XIII and XIV discuss the impacts on new sources and small businesses respectively, and Chapter XV discusses the limitations of the analysis.

CHAPTER II

ECONOMIC IMPACT ANALYSIS METHODOLOGY

II. ECONOMIC IMPACT ANALYSIS METHODOLOGY

A. OVERVIEW

This section describes the analytical approach that is used to estimate the economic impacts of effluent guidelines controls on the nonferrous metals manufacturing industry. This industry includes plants that produce primary metals from ore concentrates and plants that recover secondary metals from recycled metallic wastes. For regulatory purposes, the category is divided into two separate segments. This report covers the Phase I segment, which consists of:

- primary aluminum, lead, copper, zinc, tungsten, and columbium/tantalum production; and

- secondary aluminum, lead, copper, and silver production.

The analytical approach has been revised from the approach used at proposal in response to public comments which state that: (1) current economic conditions have not been considered in determining impacts; (2) some of the threshold values used in the analysis are not appropriate; and (3) the methodology used is not sensitive enough to capture impacts. The theoretical construct of the methodology, however, is similar to that used at proposal. The tests of plant viability focus on net present value of cash flow and liquidity.[1]

The economic impacts on each of the ten metal industries have been evaluated for specific regulatory options that correspond to varying levels of effluent control. The general approach consists of two parts:

- assessing the potential for plant closures; and

- determining the general industry-wide impacts, including changes in prices, employment, rates of return on investment, balance of trade, and small business impacts.

The assessment of plant closures is made by using two financial analysis tests: (1) a net present value (NPV) test, and (2) a liquidity test. The NPV test evaluates the impact of pollution controls on the long-term economic viability of a plant; the liquidity test measures the short-term solvency.

Production and capacity utilization behavior of the industry between 1978-1982 form the basis of assumptions used in the analysis. The approach also considers information, which has been obtained from industry and government sources, on updated industry conditions. The approach proceeds with the following steps:

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[1] Economic Impact Analysis of Proposed Effluent Limitations and Standards for the Nonferrous Smelting and Refining Industry, EPA-440-2-83-002, U.S. Environmental Protection Agency, January 1983.

1) description of production technology;
2) description of structure of the industry;
3) factors affecting demand and description of markets;
4) trends and projections of prices and capacity utilizations and consideration of baseline population;
5) calculation of annualized compliance costs;
6) assessment of plant closures;
7) determination of industry-wide impacts;
8) new source impacts; and
9) small business analysis.

Each of these steps is described below to provide a broad framework for the analysis. Then, each of the chapters (for specific metal industries) follows the same approach.

The broad framework that follows is designed to describe the basic methodology. The details of the calculations, including associated equations, are given in four appendices. The appendices also provide details on the methods and assumptions used to implement the NPV and the liquidity equations.

The major sources of data used in this study are listed below:

- U.S. Environmental Protection Agency: EPA industry surveys conducted in 1978 and 1982 under Section 308 of the Clean Water Act. Of particular importance are data on products produced, production volume, value of regulated products, value of plant shipments, capacity utilization, total employment, and employment in the regulated sector.
- U.S. Department of Commerce: Census of Manufacturers, U.S. Industrial Outlook, Quarterly Financial Report for Manufacturing, Mining and Trade Corporations.
- U.S. Department of the Interior: Mineral Industry Surveys, Mineral Facts and Problems, Minerals and Materials, Mineral Commodity Summaries, and Mineral Industry Profiles.
- The trade and business publications American Metal Market and Modern Metals.

- Interviews with trade association and industry personnel.
- Annual and 10-K reports of companies engaged in mining, smelting, and refining nonferrous metals.

B. STEP 1: DESCRIPTION OF PRODUCTION TECHNOLOGY

Nonferrous metals are produced in a series of steps that may include smelting, refining, alloying, and producing metallic chemicals. Some of these steps are covered by existing regulations (such as effluent guidelines for inorganic chemicals manufacturing) and others will be covered by future regulations. The purposes of this section are to describe the production technology in simple terms and indicate the steps involved in producing metal and metal products from ore as well as from recovered materials (scrap), and to identify the stages covered by this regulation. This information is used to provide relevant information regarding the industry structure and to classify plants into various categories.

C. STEP 2: DESCRIPTION OF STRUCTURE OF THE INDUSTRY

The structure of the industry is described in terms of:

- production, exports, and imports;
- types of manufacturers; and
- description of plants.

Time series data on production, exports, and imports are used to discuss the importance of imports, the relationship between secondary and primary production, and changes in the basic structure of the industry over time. For many of these metals, imports of either raw material or finished metals constitute a significant part of total production. Further, secondary metal industry production forms a large part of total production. High regulatory compliance costs can have significant effects on the future income of domestic producers if imports are a large part of total consumption. Similarly, secondary metal producers may find themselves at a competitive disadvantage if their compliance costs are disproportionately high.

For most of the Phase I metals, the following types of producers exist: (1) large integrated companies that produce metals from ore from their own mines; (2) integrated metals producers who also produce final products; (3) independent firms; and (4) recyclers. The characteristics of each type of manufacturer are taken into account in analyzing the economic effects.

The last part of the industry structure section is the description of plants in the industry. Plants have been classified on the basis of: (1) raw material, (2) outputs, and (3) the use of outputs. Some plants use ore; others use recycled materials; and others use byproduct ores. A few plants produce metals; others produce formed product and metallic chemicals. Some plants use the output captively, while others sell products to outside companies. The descriptions of plants, along with the structure of the companies that own the plants, are used to analyze the effects of the regulations in terms of potential plant closures. For purposes of conducting the two financial tests, each plant is first placed into one of eight business groups. Business segment information given in financial reports of almost 30 metals companies forms the data base for this classification. Two broad criteria -- type of metal and type of manufacturing processes -- have been used to form the groups. For example, primary production is separated from secondary production. The secondary production is divided into two groups: reclamation of precious metals and reclamation of non-precious metals. Primary production is divided into six groups based on metal types. Analysis of the financial data shows that significant differences in financial characteristics exist among groups. After a plant has been classified into a group it is evaluated by using the financial characteristics of the group and plant-specific information. The plants in the Phase I category fall into five of the eight groups. A description of the business groups and the development of financial characteristics for those groups are shown in Appendix B.

The business group characteristics are based on business segment information in the financial reports rather than corporate income information. This is because the business segments of a corporation can be associated closely with the operations of a plant. A corporation, especially a large one, is often an amalgam of diverse businesses, and corporate ratios based on corporate financial data may not have much relevance to the financial performance of its business segments. For this reason, business segment information is used to the extent possible. Business segment information was not always available, however. For example, corporate taxes and current assets had to be allocated to business segments because these data are not available for the segments separately. The allocation procedure is described in Appendix B.

D. STEP 3: FACTORS AFFECTING DEMAND

Changes in major end use markets of a metal can cause long-term structural changes in its demand. For example, increased production of both private and military aircraft as well as further substitutuion of aluminum for heavier metals in transportation equipment is expected to result in average annual demand growth of approximately four percent over the 1980s and 1990s. Such structural changes are likely to affect the long-term profitability of existing plants. This section in each chapter discusses the historical trends in the size of each major end-use market and assesses the impacts of the trends on overall demand.

E. STEP 4: TRENDS AND PROJECTIONS IN PRICES AND CAPACITY UTILIZATION AND CONSIDERATION OF BASELINE POPULATION

Prices of metals and metal products depend to a large extent on final demand. When the demand is high, an industry operates its plants at a relatively high capacity, the prices are high, and operating income is also high. On the other hand, when demand is low, capacity utilization, prices, and income are generally low. The trends in capacity utilization and prices, in general, parallel the trends in general economic conditions. In this study, the trends over the five-year period between 1978-1982 are used to determine economic impacts.

In order to estimate the effects of regulations, a methodology usually requires projections of product prices, number of plants, and total production at the estimated time of compliance. However, as discussed below, the methodology used for this analysis avoids the need for such projections. The analysis in this report uses the NPV and liquidity tests to determine potential plant closures. The NPV test uses long-term "constant" income, and for purposes of this analysis, this income is based on the average of income between 1978-1982. The concept of constant income is different than that of forecasting. The constant income estimated here covers the lifetime of the compliance equipment. No attempt is made to predict the value of income for a specific future year as in forecasting. While forecasting to any one future year is extremely difficult and subject to wide variation, long-term constant income can be reasonably estimated by using average historical prices and production. The 1978-1982 period is considered representative because it covers a complete business cycle; the peak in production occurred during the early years and the trough took place in 1982. Hence, averages of prices and capacity utilization during this period, used to calculate income of plants, will provide reasonable estimates of constant income.

The liquidity test evaluates short-term viability of plants by examining their cash flows. The short-term period over which financial conditions are tested is five years. Since constant income estimates are used to conduct the test, price and production forecasts are not required.

During the 1982 recession, capacity utilization in most of the nonferrous metals industries was extremely low. It was accompanied by a high level of inventories and a low level of profits. In fact, many plants were unprofitable during 1982. However, most of the plants that survived the 1982 recession are now operating at higher capacity utilization levels and in many cases have started earning profits again. It is expected that the economic recovery will continue, even if at a slow pace, and that the general economic conditions in 1985 will be somewhat better than those in 1982, but not as good as those at the peak of 1978-1979. Since 1985 will be neither a "boom" nor a "bust" year, it is reasonable to assume that: (1) most plants will operate at less than full capacity (this implies that companies will not add new capacity to their operations); and (2) plants that survived the 1982 recession will be operating in 1985. Hence, this study assumes that the plant population and the total capacity in an industry segment in 1985 will remain the same as it was in 1982.

F. STEP 5: COMPLIANCE COST ESTIMATES

Pollution control technologies result in two types of compliance costs: (1) capital costs of the control equipment, and (2) annual costs for operation and maintenance. Compliance costs are based on engineering estimates of specific treatment alternatives, and were developed for each plant after accounting for wastewater treatment already in place. Descriptions of the costing procedures and treatment alternatives are presented in the Development Document. These costs are used in this report to determine economic impacts. The increased costs have the following effects on the capital structure of a plant: (1) increased tax benefits due to investment tax credits and greater depreciation; (2) reduced overall taxes due to additional operating and maintenance costs; (3) increased asset base; and (4) increased overall production costs. The capital and annual compliance costs can be converted to total annual costs of controls as follows.

- The net present value of the tax benefits due to depreciation, which occur over the depreciable life of the equipment, is calculated.
- Tax benefits due to depreciation and investment tax credits are subtracted to obtain effective capital costs.
- Effective capital costs are amortized over the useful life of the assets to obtain annualized capital costs.
- Total annual costs are calculated by adding the annualized capital costs and annual operating and maintenance costs after taking into account tax effects of increased operating and maintenance costs.

The detailed procedures for calculating total annual costs are given in Appendix C.

G. STEP 6: PLANT-LEVEL ECONOMIC IMPACTS

Pollution controls affect plants in different ways. Some plants bear relatively high costs in order to comply with the regulations; others incur much smaller costs. It is reasonable to assume that the plants incurring relatively small costs will not close as a result of the regulations. Therefore, the analysis is conducted in two steps. First, a screening analysis is conducted to identify plants that will not be seriously affected by the regulations. Second, the NPV and the liquidity tests are carried out to determine whether plants that fail the screen will close. The screen and the two closure tests are discussed below.

1. Description of Screening Analysis

Total annual costs as a percent of annual revenues is used as the screening criterion. The threshold value chosen for the screen is 1.0 percent. If the compliance costs for a plant are less than 1.0 percent of the revenues, it is not considered to be highly affected, and is not analyzed further.

The screening analysis is conducted for each plant expected to incur compliance costs. Total annual costs are calculated by adding the annualized portion of capital costs and the annual operating and maintenance costs. Annual revenues are calculated by multiplying the price of the product by estimated production of the plant. Price values for each product are generally based on an average of 1978-1982 prices for the metal product. The specific values and their sources are presented in each chapter.

The production level for a plant is estimated by multiplying plant capacity by a subcategory capacity utilization rate. Plant capacity data were generally available from public sources. The capacity utilization rate is based on an average of 1978-1982 values for each subcategory. The subcategory rates used in the analysis are identified in each chapter.

2. Discussion of Plant Closure Tests

Pollution control expenditures result in reduction of income (when costs cannot be passed through). These expenditures may create a permanent change in income levels and thereby reduce average income in the future. The expenditures may also adversely affect a plant's short-term cash flow. The consideration of cash flow becomes important when a plant is already in poor financial health. It should be expected that such a plant will have to finance the pollution control expenditures through a bank and that the bank will not lend money for a period longer than five years -- the depreciable life of the asset for tax purposes. Negative cash flows may be created by principal and interest payments; however, there will also be positive cash flow due to tax benefits. These long-term and short-term effects of pollution control expenditures are analyzed by conducting the net present value (NPV) test and a liquidity test. Financial analysis frequently relies upon examination of cash flows. Cash flow analysis is commonly used by investors to assess the economic viability of firms in a variety of industries. In particular, cash flow analysis provides an accurate measure of a firm's profit potential over the long run and its ability to meet debt obligations in the short run. The NPV test is used to determine the long-term viability of a plant; the liquidity test addresses potential short-term cash flow problems.

a. Net Present Value Test

The net present value test is based on the assumption that a company will continue to operate a plant if cash flow from future operations is expected to exceed its current liquidation value. This assumption can be written mathematically as follows:

$$\left[\sum_{t=1}^{T} U_t \left(\frac{1}{1+r}\right)^t\right] + L_T \left(\frac{1}{1+r}\right)^T \geq L_o$$

Where: U_t = cash flow in year t =
earning before interest but after taxes (EBIAT) =
revenues - all operating expenses including depreciation at book value - taxes

L_o = current liquidation value

L_T = terminal liquidation value, i.e., liquidation value at the end of the planning horizon of T years

r = cost of capital.

In order to use this formula in this form, forecasts of the terminal liquidation value and earnings (U_t) in every year during the planning period (T) have to be made. However, the equation shown above can be simplified (and the need to make forecasts avoided) by making several assumptions. The simplified formula and the assumptions are given in Appendix A. The NPV test, after simplification and consideration of annual costs (see Appendix C), can be written as follows:

If,

$$\frac{\overline{U} - APC_p}{\overline{L}_o} \geq \overline{r} ,$$

then the plant will stay in operation.

Where: $\overline{U}$, $\overline{L}_o$, and $\overline{r}$ are, respectively, real earnings, real liquidation value, and real cost of capital (definitions of these variables are given in Appendix A); and

APC_p = total annual costs as given in Appendix C.

This equation states that if the rate of return on the liquidation value ($\overline{U}/\overline{L}_o$) is greater than or equal to the real after-tax rate of return on assets (which corresponds to $\overline{r}$), then the plant will continue in operation.

This test is carried out for every plant that fails the screen -- that is, where total annual costs are greater than 1 percent of revenues. In order to conduct the test, each plant is first classified into one of the eight groups discussed in Appendix B. Then, $\overline{U}$ and $\overline{L}_o$ are calculated (for each plant) by using various group ratios. The total annual costs are subtracted from real earnings ($\overline{U}$), and the ratio $(\overline{U} - APC_p)/\overline{L}_o$ is compared with the group's cost of capital ($\overline{r}$).

By subtracting the appropriate compliance cost (APC_p), the NPV test implicitly assumes that increased costs will not be passed through to consumers. This assumption avoids overlooking potential impacts by incorporating the full effect of the costs on a plant's earnings. This procedure is also responsive to public comments that plants cannot pass cost increases on to consumers.

b. The Liquidity Test

The basic premise of this test is that a plant will close if pollution control expenditures result in net negative cash flows in the foreseeable future. It is assumed that pollution control equipment will be financed over five years; the associated total annual costs represent cash outflows. The test can be stated in simple terms as follows (see Appendix C for details):

If

$$\bar{U} - APC_q \leq 0,$$

then the plant will close.

Where: $\bar{U}$ = real earnings (as defined above)

APC_q = total annual costs for the liquidity test (see Appendix C; note that there is a difference between APC_p and APC_q.)

The treatment of cost pass-through for the liquidity test is the same as for the NPV test; the full compliance cost is assumed to be absorbed by the plant and is subtracted from the plant's earnings.

c. Interpretation of Plant Closure Tests

A potential plant closure is projected if either of the two tests is failed. The identification of plants as potential closures in this step is interpreted as an indication of the extent of plant impact rather than as a prediction of certain closure. The decision by a company to close a plant also involves other considerations, such as non-competitive markets for products, degree of integration of operation, use of output of plants as intermediate products (captive markets), and existence of specialty markets. Most of these factors can only be evaluated qualitatively and are taken into account only after the quantitative results of the two financial tests have been obtained.

For some of the facilities included in this study, production of the relevant nonferrous metal represents only a limited portion of total production capacity at the plant. For example, some secondary silver manufacturers produce a variety of metals, many of which are not included in the Phase I segment of the industry. The production of silver may be a very small proportion of total metal production. If the closure tests are failed by a plant meeting this description, the analysis suggests it would be unprofitable for the plant to continue operations for the metal associated with the compliance cost. In this case, the effect is identified as a production line closure. It is not reasonable to extend this conclusion to the entire production facility because the compliance costs, sales, and plant closure tests are all based on production of the one metal.

H. STEP 7: INDUSTRY-WIDE IMPACTS

As compared to the plant-level closure analysis, this step focuses on impacts that are likely to occur at an industry-wide level. These impacts include effects on: (1) cost of production; (2) prices; (3) return on investment; (4) capital expenditures; (5) employment and communities where plants and their suppliers are located; and (6) balance of trade.

Each of these impacts is calculated for each subcategory, and the results are presented in Chapters III through XII. The calculations rely on both group ratios and plant-specific information. The equations used to calculate the impacts are shown in Appendix D.

1. Changes in the Cost of Production

The financial impact of the regulatory alternatives on each industry is evaluated in terms of the increase to cost of production. This impact is measured by calculating the ratio of total annual compliance cost to total production cost, where production costs are calculated as plant revenues less operating income. This ratio represents the percentage increase in operating costs due to compliance expenditures.

2. Price Changes

The price change is the ratio of total annual compliance cost to annual plant revenue. This ratio represents the maximum percentage increase in price that would be required to maintain pre-compliance income levels. It is calculated with the assumption of full pass-through of costs. This assumption of full pass-through is not used in the closure analysis, but only in the calculation of price changes.

3. Changes in Return on Investment

Return on investment is calculated before and after the imposition of compliance costs. The return on investment before compliance costs is the value $\bar{r}$, which is computed for each group. The return on investment after compliance costs accounts for the effect of these costs on both income and assets. Annual compliance costs act to reduce income, while capital costs increase the asset base. A percentage change in return on investment is then derived from the two values. The change in return on investment represents the change in earnings per dollar of assets that is expected to result under each treatment option.

4. Effects on Capital Expenditures

This impact compares the capital compliance cost to expected capital expenditures. This ratio represents the percentage of additional capital expenditure needed to comply with each treatment option while maintaining previous investment programs.

5. Employment Impacts

Employment impacts are measured by the total number of jobs lost at plants expected to close. Employment estimates for production facilities projected to close are based on individual plant production data obtained from the Agency's survey of the industry and an estimate of production per employee. Community impacts are assessed by comparing the number of job losses due to the regulations to total employment in the community. Data on community employment are available through the Bureau of the Census and the Bureau of Labor Statistics.

6. Effects on the Balance of Trade

The economic impact of this regulation on foreign trade is the combined effect of price pressure from higher costs and production loss due to potential plant closure. The impact on foreign trade is discussed in the context of these two effects.

I. STEP 8: NEW SOURCE IMPACTS

New facilities and existing facilities that undergo major modifications are subject to NSPS/PSNS guidelines. Compliance costs of new source standards have been defined as incremental costs over the costs of selected standards for existing sources. The purpose of this approach is to determine if control costs constitute significant barriers to the entry of new sources into the industry.

J. STEP 9: SMALL BUSINESS ANALYSIS

The Regulatory Flexibility Act (RFA) of 1980 (P.L. 96-354) requires Federal regulatory agencies to consider "small entities" throughout the regulatory process. In this study, an initial screening analysis is performed to determine if a substantial number of small entities will be significantly affected. This step identifies the economic impacts likely to result from the promulgation of regulations on small businesses. The primary economic variables that are covered are those that are analyzed in the general economic impact analysis, including compliance costs, plant financial performance, plant closures, and unemployment. Most of the information and analytical techniques in the small business analysis are drawn from the general economic impact analysis which is described above.

CHAPTER III

PRIMARY ALUMINUM

III. PRIMARY ALUMINUM

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States primary aluminum industry of alternative pollution control technologies.

The technology used in aluminum production is discussed in Section B. The structure of the domestic industry, including the size and location of the plants, is presented in Section C. Section D describes aluminum demand characteristics and major end markets; Section E discusses current trends of the domestic industry. Estimates of prices and capacity utilization for the industry are made in Section F. Section G presents the cost estimates for the alternative control technologies, and Section H presents the results of the economic impact analysis.

All compliance cost and economic impact information is stated in 1982 dollars, unless otherwise indicated.

B. TECHNOLOGY

The primary aluminum industry produces aluminum (metal) from bauxite ore in two basic operations:

1) Refined alumina (Al_2O_3) is produced from bauxite by the Bayer process, and

2) The alumina is converted to aluminum metal by electrolytic reduction in the Hall-Heroult process.

These two operations are conducted at separate locations. This regulation covers only the second operation, that is, conversion of alumina to aluminum metal.

Most U.S. aluminum plants produce primary aluminum from refined alumina by the conventional Hall-Heroult process. This is an electrolytic reduction process that decomposes alumina to aluminum metal.

A Hall-Heroult cell consists of a steel box lined with insulating refractory and carbon. The cell is filled with a molten electrolyte containing 80-85 percent cryolite (Na_3AlF_6), 5-7 percent calcium fluoride (CaF_2), 5-7 percent aluminum fluoride (AlF_3), and 2-8 percent alumina. A carbon anode is suspended in the electrolyte from above the cell and carbon blocks at the bottom of the cell serve as the cathode. During operation, the alumina decomposes to aluminum and oxygen. The molten aluminum settles to the bottom of the cell on the cathode and is periodically siphoned off. The oxygen liberated at the anode reacts with the carbon anode, forming CO_2 and CO, which are released.

There are two versions of the Hall-Heroult cell, which differ mainly in the nature of the carbon anode: the Soderberg (continuous self-baking) type and the prebaked type. The early, larger (high-amperage) cells had low current densities and used Soderberg anodes because prebaked anodes large enough for the high-amperage cells were originally difficult to produce, and the capital cost for a moderate-sized plant was lower with Soderberg cells. However, industry has since learned how to make large prebaked anodes and is building larger capacity reduction plants using prebaked anodes. All the smelters built in the last 15 years have been of the prebake type because they require less power, present fewer pollution problems, and are less difficult to control and automate than the Soderberg smelters.

C. INDUSTRY STRUCTURE

1. Overview

The domestic aluminum industry has always depended largely on imports for most of its supply of bauxite. A comparative picture of the United States with respect to other countries is presented in Table III-1. Although the United States consumes almost 26 percent of world aluminum production and produces 24 percent of the world's primary aluminum, it produces less than 1 percent of the world's bauxite. The members of the International Bauxite Association (IBA) account for about 69 percent of total world production of bauxite and, therefore, collectively constitute a cartel. Australia dominates this category with about 30 percent of total bauxite production.

Worldwide recessionary conditions in the early 1980s resulted in a decline in U.S. production and exports, as shown in Table III-2. Primary production fell approximately 27 percent in 1982 from the 1981 level of 4,950 thousand short tons. Exports totalled 780 thousand short tons, down 10 percent from 1981.

2. Primary Aluminum Smelters

The U.S. primary aluminum industry encompasses 33 aluminum smelters operated by 12 firms, 4 of which (Alcoa, Kaiser, Martin Marietta, and Reynolds) account for more than 66 percent of total domestic ingot-producing capacity. These plants, their production capacities, and configurations are presented in Table III-3. Total primary aluminum capacity in 1982 was more than 5 million short tons, with individual plant capacities ranging from 16,500 to 341,700 short tons per year.

The location of the domestic smelters is basically determined by the availability of low-cost energy and accessibility to river systems for the transportation of alumina. Aluminum refining is an energy-

TABLE III-1

WORLD ALUMINUM INDUSTRY, 1982

Country	Bauxite Mined		Primary Refined Aluminum		Consumption	
	(000 short tons)	% World	(000 short tons)	% World	(000 short tons)	% World
United States	759.5	0.86	3,609	23.92	3,880	25.34
Members of International Bauxite Association	60,523.8	68.63	857.5	5.68	436.6	2.8
Other	26,894	30.49	10,620.7	70.39	10,993.1	71.80
Total	88,177.3	100.00	15,087.2	100.00	15,309.7	100.00

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics, Inc.

Detail may not add to total because of rounding.

TABLE III-2

U.S. PRODUCTION, IMPORTS, AND EXPORTS

(thousands of short tons)

	1978	1979	1980	1981	1982
1. **Production:** Primary	4,804	5,023	5,130	4,950	3,600
Secondary (from old scrap)	575	614	680	886	950
2. **Imports for Consumption**	1,080	840	713	935	970
3. **Exports**	520	773	1,483	867	780

SOURCE: Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE III-3

ALUMINUM INGOT PRODUCTION CAPACITY

(end of 1982 - short tons)

Company	Location of Plant	Smelter Technology	Annual Capacity
Aluminum Company of America	Evansville, IN	CWPB	292,000
	Badin, NC	CWPB	126,800
	Massena, NY	CWPB	226,000
	Alcoa, TN	CWPB	220,500
	Anderson County, TX	CWPB	16,500
	Point Comfort, TX	VSS	159,800
	Rockdale, TX	CWPB	341,700
	Vancouver, WA	CWPB	121,200
	Wenatchee, WA	CWPB	220,500
Subtotal			1,725,000
Alumax			
Eastalco (50% interest)	Frederick, MD	SWPB	88,200
Intalco (50% interest)	Bellingham, WA	SWPB	140,000
Santa Carolina	Mount Holly, SC	SWPB	197,000
Subtotal			425,200
ARCO Aluminum	Columbia Falls, MT	VSS	180,000
Division of ARCO Metals	Sebree, KY	CWPB	180,000
Subtotal			360,000
Consolidated Aluminum	New Johnsonville, TN	SWPB	146,000
Corporation	Lake Charles, LA	SWPB	36,000
Subtotal			182,000
Howmet Corp.			
Eastalco (50% interest)	Frederick, MD	SWPB	88,200
Intalco (50% Interest)	Bellingham, WA	SWPB	130,500
Subtotal			218,700
Kaiser Aluminum and	Chalmette, LA	HSS	260,000
Chemical Corporation	Mead, WA	CWPB	220,000
	Tacoma, WA	HSS	81,000
	Ravenswood, WV	CWPB	163,000
Subtotal			724,000

Continued

TABLE III-3 (Continued)

Company	Location of Plant	Smelter Technology	Annual Capacity
Martin Marietta Aluminum, Inc.	The Dalles, OR	VSS	90,000
	Goldendale, WA	VSS	185,000
Subtotal			275,000
National-Southwire Aluminum Co.	Hawesville, KY	CWPB	180,000
Noranda Aluminum, Inc.	New Madrid, MO	CWPB	225,000
Ormet Corp.	Hannibal, OH	CWPB	250,000
Revere Copper and Brass Inc.	Scottsboro, AL	SWPB	120,000
Reynolds Metals Co.	Listerhill, AL	HSS	202,000
	Arkadelphia, AR	HSS	68,000
	Jones Mills, AR	CWPB	125,000
	Massena, NY	HSS	126,000
	Troutdale, OR	CWPB	130,000
	San Patricio, TX	HSS	114,000
	Longview, WA		210,000
Subtotal			975,000
Total			5,659,900

SOURCE: Non-Ferrous Metals Data -- 1982,
American Bureau of Metal Statistics, Inc.

CWPB = Center-Worked Prebake Cells.
SWPB = Side-Worked Prebake Cells.
HSS = Horizontal Soderberg System.
VSS = Vertical Soderberg System.

intensive process, consuming 3.3 percent of all electricity generated in 1982. Aluminum plants are located in four general areas:

- along the Mississippi and Ohio Rivers, because of the availability of low-cost coal-based electricity and the transportation system provided by the rivers;
- along the Gulf Coast, because of previously low-cost natural gas resulting in low-cost purchased or self-generated electrical energy;
- in Massena, New York, because of the access and transportation advantages provided by the St. Lawrence Seaway and the availability of low-cost hydroelectric and nuclear power; and
- in Washington, Oregon, and western Montana, principally because of the availability of low-cost hydroelectric power.

D. ALUMINUM DEMAND

Demand for aluminum exhibited steady growth between 1965-1978. Since 1978, weak markets in the automobile production and residential construction industries have resulted in declining consumption. Between 1978 and 1982, aluminum consumption fell by 16.8 percent to 5,940,000 short tons (Table III-4).

Packaging is the largest end-use for aluminum in the United States, followed by transportation, building construction, the electrical industry, and appliances and equipment (Table III-5).

1. Construction Industry

In the construction industry, the two major applications for aluminum are in windows, doors, and screens, and in external cladding for walls and roofs. Aluminum is used for primary construction and, even more widely, in building renovation (particularly residential). The recent growth in mobile homes has also contributed to the demand for aluminum in the building market. Other building and construction applications are tubing, piping, roofing, and gutters. Building construction accounted for 14 percent of total aluminum consumption in 1982, the lowest since 1971. Weak markets in the residential construction industry and competition from steel were major factors for the low amount of consumption in this sector.

2. Transportation

The domestic transportation industry has historically accounted for about 20 percent of aluminum consumption. In 1981 and 1982, weak domestic passenger car sales contributed to a large decline in aluminum consumption. However, aluminum alloys are becoming increasingly popular substitutes for steel in the automobile industry because of the weight factor, although they face competition from magnesium and titanium. From an average of 30 pounds of aluminum used per car in 1955, an

TABLE III-4

U.S. ALUMINUM CONSUMPTION

(thousand short tons)

Year	Consumption
1965	3,095
1970	4,519
1975	4,806
1978	7,142
1979	7,058
1980	6,123
1981	6,224
1982	5,940

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics, Inc.

TABLE III-5

U.S. ALUMINUM DEMAND BY END USE

(percent of total demand)

	1971	1976	1978	1979	1980	1981[a]	1982[b]
Construction	28.20	24.30	23.41	22.50	21.99	21.11	14.00
Transportation	18.20	21.01	22.60	22.71	18.89	17.91	20.00
Cans and Containers	15.40	22.31	22.99	23.79	28.00	29.41	39.00
Electrical	14.41	10.90	10.80	11.60	11.61	11.09	8.00
Appliances and Equipment	9.91	8.79	8.40	7.59	7.40	8.20	8.00
Other	13.89	12.69	11.79	11.80	12.10	12.29	11.00
Total	100	100	100	100	100	100	100

SOURCE: Mineral Commodity Profiles, Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983.

Detail may not add to total due to rounding.

[a] Preliminary.

[b] Estimated.

average of 118 pounds was used in the 1979 models. In 1979, passenger cars accounted for one-half of total transportation uses; trucks, buses, trailers, and semi-trailers accounted for about one-quarter of the aluminum used in this sector. The high strength and light weight of aluminum have been most important in aircraft, which accounted for about 10 percent of the transportation sector in 1979. Other transportation uses include commercial and naval marine vessels, and rail, military, and recreational vehicles.

3. Cans and Containers

Packaging has been the fastest growing major aluminum market, accounting for 15 percent of aluminum consumption in 1971, 23 percent in 1978, and 39 percent in 1982. Sheet shipments for use in can production have tripled since 1970. In 1981, aluminum can market shipments increased 14 percent with approximately 43 billion aluminum beverage cans used in the United States. Aluminum is becoming popular because much of it is recyclable; it now substitutes in durable goods for many other materials, primarily steel, wood, zinc, and brass.

4. Electrical

Overhead electrical transmission and distribution lines were the first applications in which the substitution of aluminum became a serious threat to copper. Aluminum has captured this market worldwide; in 1979 it accounted for about 70 percent of total aluminum consumed in this sector. Other applications include plastic-insulated aluminum telephone cables, television cables, electronics and communication equipment and parts, rigid conduit and electrical metallic tubing, and wire for home electrical conductors. This sector accounted for 8 percent of the total aluminum consumption in 1982.

5. Appliances and Equipment

Aluminum consumption in this sector has remained relatively stable at approximately 8 percent. Refrigerators, air conditioners, washing machines, furniture, utensils, and other consumer appliances and equipment are important markets in this sector.

6. Other Uses

Machinery and equipment comprise the major end-use market in this category. Major applications are for special industrial machinery, agricultural machinery, materials handling equipment, and irrigation equipment.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

The world aluminum industry has experienced a major restructuring as a result of the recent economic recession. Both large integrated and small independent aluminum companies divested their unprofitable sectors in 1981 and 1982. U.S. primary metal production was cut back during 1981 and 1982 to about 58 percent of annual capacity as a result of low demand, low prices, and high energy costs. By late 1982, six primary plants, representing 791,000 short tons of capacity, remained idle. Inventories in the hands of producers climbed to record levels. Consequently, aluminum prices fell sharply from their historic averages.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in aluminum production will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the period 1978-1982. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the aluminum industry.

The aluminum price used for this analysis is based on U.S. producer list prices. Historically, producer prices and market prices have been generally the same. The two diverged somewhat in 1981 and 1982 due to widespread price discounting. However, the Department of the Interior's Bureau of Mines projects primary aluminum demand to increase at an annual average rate of 4 percent from 1981 to 2000 (Mineral Commodity Profiles, Bureau of Mines, 1983). Consequently, the disparity between producer and market prices is not expected to persist. The aluminum price for the analysis is $1,567.08 per ton (see Table III-6).

The capacity utilization rate is 87 percent (see Table III-7). For both prices and capacity utilization rates, the values used in the analysis show improvement over 1982. This is consistent with the overall improvement in the industry predicted by the Bureau of Mines and the Bureau of Industrial Economics (U.S. Industrial Outlook, U.S. Department of Commerce, 1983).

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the primary aluminum industry are described in the Development Document. The treatment options considered for the industry are as follows:

- Option B - This option includes recycle of casting contact cooling water using cooling towers (where required), preliminary treatment using cyanide precipitation on certain streams, equalization, oil skimming, chemical precipitation, and gravity settling.

- Option C - This option includes Option B plus multimedia filtration of the final effluent.

- Option E - This option includes Option C plus activated carbon adsorption on the final effluent when organics are present. This option applies only to plants with organic pollutants in their wastestreams.

TABLE III-6

U.S. ALUMINUM PRICES

Year	Cents per Pound		1982 Dollars per Ton
	Actual	1982 Dollars	
1978	54	74.40	1,488.00
1979	61	77.32	1,546.40
1980	72	83.49	1,669.80
1981	76	80.56	1,611.20
1982	76	76.00	1,520.00
		Average =	1,567.08

SOURCE: Mineral Commodity Profiles,
U.S. Department of the Interior,
Bureau of Mines, 1983.

TABLE III-7

PRIMARY ALUMINUM PRODUCTION AND CAPACITY

(thousand short tons)

Year	Production	Capacity	Capacity Utilization
1978	4,804	5,197	92%
1979	5,023	5,282	95%
1980	5,130	5,503	93%
1981	4,948	5,467	90%
1982	3,609	5,487	65%
		Average	= 87%

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

2. Costs for Existing Plants

The compliance cost estimates developed for each of the plants in the aluminum industry, for each level of control, are presented in Table III-8.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

For the screening assessment, the plant-specific compliance costs for alternative control technologies are evaluated against anticipated revenue. The annual compliance cost includes operating and maintenance costs, and annualized capital costs. The estimated revenues are based on the subcategory price and capacity utilization rate. If the compliance cost represents more than 1 percent of anticipated revenue, the plant is considered for further analysis. The results of the screening assessment show that none of the affected primary aluminum smelters exceed the threshold value of 1 percent. The largest ratio calculated for the selected option was 0.31 percent. Since no plants fail the screening analysis, no additional closure tests are applied. These results suggest that the compliance costs will not have a significant effect on any of the facilities.

2. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

The effect of compliance costs on the financial performance of the primary aluminum industry is evaluated in terms of the increase in cost of production. Since plant-specific unit cost of production is not known, an estimate of the increase in the cost of production is made by assuming that revenues minus operating income equals cost of production. The estimated increase in the cost of production is shown in the following table.

	Increase in Cost of Production		
	Option B	Option C	Option E
Direct Dischargers	0.12	0.13	0.17

TABLE III-8

PRIMARY ALUMINUM -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs			Total Annual Costs		
	Option B	Option C	Option E[a]	Option B	Option C	Option E[a]
Direct Dischargers						
340	234,850	258,362	--	65,257	72,579	--
341	378,523	423,486	--	116,144	131,404	--
342	748,962	847,825	1,062,050	342,479	375,714	498,030
343	2,043,525	2,172,912	3,785,375	702,673	748,102	1,107,940
347	331,787	382,662	--	118,192	135,545	--
348	551,100	605,825	821,838	151,626	171,357	295,076
351	302,073	332,461	--	88,210	97,747	--
352	447,548	495,536	--	144,924	161,269	--
353	617,760	714,835	1,979,423	312,062	344,686	610,317
354	1,039,225	1,149,362	2,572,625	490,795	527,832	832,127
355	300,146	333,421	--	106,458	117,267	--
356	120,711	143,948	263,986	51,960	59,183	85,995
357	335,362	391,600	--	173,667	192,458	--
359	898,975	1,010,075	2,640,413	352,272	394,177	759,139
360	258,637	331,925	1,315,738	130,141	154,816	349,244
362	171,325	191,262	--	55,390	61,093	--
363	1,310,155	1,400,217	2,595,093	1,013,558	1,043,884	1,288,439
364	324,087	373,587	572,688	89,835	106,692	216,162
365	441,523	446,586	600,449	135,710	143,778	200,870
367	334,386	366,561	481,924	113,007	123,354	154,619
368	770,131	820,008	1,023,096	446,523	463,525	576,050
369	1,112,750	1,228,250	1,698,050	648,288	689,139	823,517
370	902,700	946,425	1,123,663	421,646	437,741	525,964
371	666,311	728,186	982,699	291,844	312,568	467,988
Total	14,642,552	16,095,317	23,519,110	6,562,660	7,065,909	8,791,478

SOURCE: U.S. Environmental Protection Agency.

Detail may not add to total because of rounding.

[a] Option E costs are applicable to those plants with wastestreams containing organic pollutants.

As shown in the table, the maximum increase in the cost of production is only 0.17 percent. These changes in the cost of production are minimal and are not expected to significantly affect the domestic industry structure.

b. Price Change

The price change is expressed as the total annual costs as a percent of plant revenues. If the compliance costs are completely passed through in the form of higher prices (an assumption not used in the screening and closure analyses), this ratio represents the maximum price increase attributable to compliance costs.

	Price Change		
	Option B	Option C	Option E
Direct Dischargers	0.11	0.12	0.15

As shown in the table, the price effect ranges from 0.11 percent under Option A to 0.15 percent under Option C. These small changes would not be expected to significantly affect the domestic industry structure.

c. Change in Return on Investment

The primary aluminum industry is a highly capital-intensive and energy-intensive industry. With both capital costs and energy costs rising sharply, industry profitability is expected to decrease in the near future. This decrease as a result of pollution control costs is shown below.

	Change in Return on Investment		
	Option B	Option C	Option E
Direct Dischargers	-1.89	-2.04	-2.62

As shown in the table, the overall profitability of the industry, in terms of return on investment, is expected to decline by 2.62 percent under Option E, and by less under other options. Even at Option E, the reduction in return on investment is not expected to adversely affect the industry.

d. Capital Impacts

The incremental compliance capital costs for each of the primary aluminum plants have been compared to the average annual capital expenditures of primary aluminum plants. The results of the assessment are presented in the following table.

	Investment Cost as a % of Capital Expenditures		
	Option B	Option C	Option E
Direct Dischargers	2.15	2.36	3.45

Investment costs are not a significant portion of average capital expenditures. Investment costs amount to only 3.45 percent of average expenditures for Option E.

e. Employment Impacts

No incremental effects on production or employment are projected for this industry, and demand is expected to remain stable. With unchanged demand, and negligible price increases even under the assumption of full pass-through of costs, production and employment are also expected to remain unchanged as a result of compliance costs.

f. Foreign Trade Impacts

The impact of regulatory costs on the balance of trade is examined in the context of increases in imports. However, since the changes in prices and production are not expected to be significant, it is estimated that the industry growth rate will not be hampered. Hence, with no general rise in imports, there should be essentially no change in the balance of trade as a result of these regulations.

CHAPTER IV

PRIMARY COPPER

IV. PRIMARY COPPER

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States primary copper industry of alternative pollution control technologies.

The technology used in copper production is discussed in Section B. The structure of the domestic industry, including the size, location, and ownership of the plants, is presented in Section C. Copper demand and end use characteristics are discussed in Section D and the current trends of the industry are discussed in Section E. Estimates of price and capacity utilization to 1985 are given in Section F. Section G presents the cost estimates for the alternative control technologies, and Section H presents the results of the economic impact analysis.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise noted.

B. TECHNOLOGY

There are many types of copper ore but commercially recoverable deposits are either sulfides or, less commonly, oxides. Occasionally, copper is extracted from complex minerals containing other metals such as lead or zinc.

The ores are concentrated by crushing or flotation. Copper salts may be extracted by leaching, i.e., treating the ore with an acid that will preferentially combine with the copper. The resulting copper-rich solution can, in turn, be treated to extract the metal. Leaching is particularly useful for refining low-grade ores or mine waste. Many copper ores contain other useful nonferrous metals such as molybdenum, cobalt, and selenium, and methods to extract these metals in refinable form are incorporated in the copper refining process.

The ores may first be roasted, if the required desulfurization is impossible in the smelting process. The smelter produces an impure form of metal known as blister copper, which is cast into large flat ingots. These are used as anodes for the electrolytic refining process, which is carried out in the normal way using thin sheets of pure copper as cathodes, onto which the copper is plated.

C. INDUSTRY STRUCTURE

1. Overview

The U.S. and the U.S.S.R. are the largest copper-producing countries in the world, each accounting for between 13-18 percent of total mine, smelter, and refined production. These two countries together account for about 33 percent of total refined consumption (Table IV-1). However, the U.S. remains a net importer of refined copper -- a trend that began in the early 1970s (Table IV-2). The bulk of imports made by the United States and the rest of the developed world are supplied by members of the Intergovernmental Council of Copper Exporting Countries (CIPEC).

2. Primary Copper Smelters and Refineries

In 1982, the U.S. primary copper smelting and refining industry was comprised of 15 smelters and 21 refineries. A partial listing of these plants and their approximate capacities is shown in Table IV-3. Traditionally, the smelters have been situated near the mines in order to minimize transportation charges for concentrates. Since the major copper mines are centered in the West, most of the smelting capacity is in that area. Most firms are integrated vertically, to different degrees, from mining through refining. A few are also further integrated, either directly or through subsidiaries, into fabrication.

3. Description of Plants

Four of the producers participate either directly or through subsidiaries in all stages of production: Kennecott, Phelps Dodge, Asarco, and Copper Range. Magma and Inspiration are integrated vertically from mining through refining and produce semi-fabricated shapes. Most of the major copper producers are also integrated horizontally into other metals such as gold, silver, lead, zinc, and aluminum.

The productive capacities of the different stages of production for vertically integrated companies are not always evenly matched. The most important comparison is between mine output of copper concentrate and the smelter feed capacity for concentrate. If a company's mines cannot produce sufficient concentrate feed for its smelters, the company can either buy concentrate from non-integrated mining companies, or it can process concentrates owned by others for a fee, or toll. The former is referred to as a custom smelter, the latter as a toll smelter.

D. COPPER DEMAND

Demand for copper is a derived demand, since copper is used as an intermediate input in the production of goods for consumption. The largest sources of demand are wire and brass mills (see Table IV-4). The major industrial markets are described below.

- Wire mills, which use only refined copper, accounted for 74.2 percent of refined copper consumption (52.2 percent of total consumption) in 1982. The major products from these mills are bare wire, and insulated wire for communications and other uses.
- Brass mills, which consume refined copper and scrap in fairly equal proportions, accounted for about 34 percent of total consumption in 1982. The major brass mill products are sheet,

TABLE IV-1

WORLD COPPER INDUSTRY -- 1982

(thousand short tons)

Country	Production						Refined Consumption	
	Mine Production	% World	Smelter Production	% World	Refined Production	% World	Amount	% World
United States	1,253.5	14.09	1,125.0	12.65	1,843.3	18.09	1,828.4	18.31
U.S.S.R.	1,257.0	14.13	1,278.7	14.38	1,609.4	15.80	1,455.0	14.57
Important CIPEC Members[a]	2,899.1	32.58	2,687.0	30.22	1,931.4	18.96	65.3	0.65
Other	3,486.5	39.19	3,802.0	42.73	4,801.9	47.14	6,637.5	66.46
	8,896.1	100	8,892.7	100	10,186.0	100	9,986.2	100

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics, Inc.

Detail may not add to total due to rounding.

[a] The important CIPEC members are Peru, Chile, Zambia, and Zaire.

TABLE IV-2

U.S. IMPORTS AND EXPORTS OF REFINED COPPER

(thousand metric tons)

Year	Imports	Exports	Net Exports (Imports)
1972	160	166	6
1974	284	115	(169)
1975	130	156	26
1977	351	47	(304)
1978	403	92	(311)
1979	204	74	(130)
1980	427	14	(413)
1981	331	24	(307)
1982	258	31	(227)

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE IV-3

PRIMARY COPPER INDUSTRY -- PLANTS AND LOCATIONS

Company	Copper Smelters End of 1982 Short Tons of Feed Capacity		Copper Refineries End of 1982 Short Tons		
	Location of Smelter	Annual Capacity	Location of Refinery	Type	Annual Capacity
Asarco Incorporated	El Paso, TX	576,000	Amarillo, TX	Electrolytic	420,000
	Hayden, AZ	960,000			
	Tacoma, WA	600,000			
Tennessee Chemical Company	Copperhill, TN	18,000			
Inspiration Consolidated Copper Company	Inspiration, AZ	450,000	Inspiration, AZ	Electrolytic	70,000
Magma Copper Company					
San Manuel Division	San Manuel, AR	800,000	San Manuel, AR	Electrolytic	215,000
Kennecott Corporation					
Nevada Mines Division	McGill, NV	255,000	Garfield, UT	Electrolytic	213,000
Chino Mines Division	Hurley, NM	300,000	Anne Arundel County, MD	Electrolytic	276,000
Ray Mines Division	Hayden, AZ	360,000	Hurley, NM	Fire	103,000
Utah Copper Division	Garfield, UT	820,000			
Phelps Dodge Corporation					
Douglas Smelter	Douglas, AZ	700,000	El Paso, TX	Electrolytic/ Fire	420,000/ 25,000
Morenci Branch	Morenci, AZ	900,000	Laurel Hill, L.I., NY	Electrolytic/ Fire	72,000/ 20,000
New Cornelia Branch	Ajo, AZ	250,000			
Tyrone Branch	Playas, NM	640,000			
Copper Range Company[a]					
White Pine Copper Division	White Pine, MI	20,000	White Pine, MI	Electrolytic	60,000
Total		7,869,000	Total		1,894,000

SOURCE: Non-Ferrous Metal Data -- 1982, American Bureau of Metal Statistics, Inc., 1982.

[a] Tons of product.

TABLE IV-4

CONSUMPTION OF COPPER PRODUCTS BY INDUSTRY, 1982[a]

(thousand of short tons of copper content)

	Refined Copper[b]	Scrap	Total	Percent Breakdown
Wire Mills	1,356.4	--	1,356.4	52.2%
Brass Mills[b]	433.3	447.5	880.8	33.9
Foundries[b]	15.1	72.1	87.2	3.4
Powder Mills[b]	6.5	10.1	16.6	0.6
Ingot Makers	4.4	173.2	177.6	6.9
Other[b,c]	12.7	66.1	78.8	3.0
Total	1,828.4	769.0	2,597.4	100.0%

SOURCE: Copper Development Association, Copper Supply and Consumption Annual Data.

[a] Preliminary.

[b] Direct consumption only: not including consumption of copper in ingots from ingot makers.

[c] Chemical, steel, aluminum, and other industries.

strip and plate, rod, bar and mechanical wire, plumbing tube and pipe, and commercial tube and pipe.

- Ingot makers, who use almost entirely scrap, were the third largest consumers of copper at 6.9 percent in 1982. These intermediate processors sell to brass mills, foundries, powder plants, and other industries.

- Foundries accounted for 3.4 percent of refined copper consumption in 1982. The major foundry products are sand castings, die castings, and permanent mold castings.

- Powder plants accounted for less than 1.0 percent of refined copper consumption in 1982.

The electrical and electronics industry group has grown to be the principal consumer of copper, accounting for almost 60 percent of all copper consumption in 1982 (Table IV-5). Aluminum has been competing with copper in electrical uses since the 1950s, and in 1982 the two metals had roughly equal shares of the annual market when measured on a conductance basis.

Building construction continues to be a significant consumer of copper for electrical wiring and pipe, accounting for approximately 30 percent of U.S. annual copper consumption. The use of plastics in drainage plumbing has posed a potential threat to copper in this sector.

Transportation accounted for about 7 percent of total consumption between 1972-1982. The automotive industry is the biggest consumer of copper in this sector. Both the building construction and transportation industries were particularly affected by the recession and the high interest rates that accompanied it, which effectively reduced production levels in copper smelters and refiners.

The other principal copper-using industries -- industrial machinery and equipment, ordnance, and coinage, together accounted for about 17 percent of total consumption in 1982. Substitution of plastics and stainless steel in machine parts, and substitution of aluminum in commercial air conditioning and refrigeration units, has somewhat reduced the demand for copper in this sector. The requirements for ordnance fluctuate widely, depending on the degree of military mobilization. Copper consumption in coinage dropped by nearly 40,000 tons when copper pennies were replaced by copper-plated zinc pennies.

E. CURRENT TRENDS — CAPACITY UTILIZATION AND PRICES

Copper is traded on both the London Metal Exchange (LME) and the COMEX exchange in New York, and almost all of the world's trade in the metal is based on the price traded on one or the other of these markets. U.S. producers now follow Comex pricing, even though most of them are highly vertically integrated. Comex and LME prices are used as a basis for the sale of copper in all stages of its treatment, including ores, concentrates, blister copper, cathodes, wire bars, semi-fabricated

TABLE IV-5

U.S. DEMAND BY END USE
(thousand metric tons)

End Use	1978	1979	1980	1981	1982
Electrical	1,284	1,318	1,194	1,223	1,039
Construction	472	487	423	449	322
Machinery	273	292	271	293	187
Transportation	198	195	152	174	100
Ordnance	24	18	27	25[a]	25[a]
Other	118	122	109	114	88
Total Demand	2,369	2,432	2,176	2,278	1,761
Total U.S. Primary Demand (industrial demand less old scrap)	1,868	1,828	1,562	1,680	1,243

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

[a] Estimated.

products, and scrap. Several countries rely heavily on copper as a source of foreign exchange, and they are reluctant to cut production (and, in fact, tend to increase output), as prices fall, in an effort to stem the erosion of needed currency. This was the situation for most of 1982, and the result was a worsening of the world oversupply.

The domestic copper industry suffered a setback during 1982 as demand, production, prices, and profitability all declined. By July 1983, U.S. copper mines were operating at about 60 percent of capacity, having operated at less than 50 percent of capacity in the late summer of 1982. Thirteen of the 25 largest mines and four of the 15 primary domestic copper smelters were closed. U.S. mine production has not attained a rate consistently above 80 percent of capacity since 1974. The industry appeared to begin a recovery in 1983.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the production of copper will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the 1978-1982 period. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the copper industry.

The copper price used for this analysis is based on U.S producer list prices. As discussed in the previous section, U.S. producer prices have historically been close to LME prices. Both copper smelters and refiners are included in this analysis. The product prices used correspond to the specific production activity (i.e., smelting or refining). The price of refined copper for the analysis is $1,972.40 per ton (see Table IV-6). The price for smelted copper is computed on the basis of the ratio of smelting capacity to refining capacity. It is assumed that refiners contribute 10 percent to the value of the product. Therefore, the approximate computed price for smelted copper is $1,972.40 x 0.26 x 0.9 = $461.54. Data on the ratio of smelting to refining capacity and the value added at smelters were obtained from the Department of Commerce's Bureau of Census (1977 Census of Manufactures).

The capacity utilization rate is 66 percent (see Table IV-7). For both prices and utilization rates, the values used in the analysis show improvement over 1982. This is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM) which shows an overall improvement in the primary copper industry. Specifically, the BOM projects primary copper demand to increase at an annual average rate of 1 percent from 1981 to 2000 (Mineral Commodity Profiles, Bureau of Mines, 1983).

TABLE IV-6

AVERAGE ANNUAL U.S. PRODUCER COPPER PRICE

Year	Cents Per Pound		1982 Dollars per Ton
	Actual	1982 Dollars	
1978	66.5	91.6	1,832.00
1979	93.3	118.3	2,366.00
1980	102.4	118.7	2,374.00
1981	85.1	90.2	1,804.00
1982	74.3	74.3	1,486.00
			Average = 1,972.40

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE IV-7

CAPACITY UTILIZATION RATES FOR U.S. SMELTERS AND REFINERIES

	1978	1979	1980	1981	1982
Smelting					
Production (000 metric tons)	1,228	1,336	1,008	1,317	976
Capacity (000 metric tons)	1,870	1,870	1,690	1,690	1,690
Capacity Utilization Rate (percent)	66%	71%	60%	78%	58%
	Average = 67%				
Refining					
Production (000 metric tons)	1,246	1,311	1,013	1,320	1,054
Capacity (000 metric tons)	2,080	1,940	1,710	1,710	1,568
Capacity Utilization Rate (Percent)	60%	68%	59%	77%	67%
	Average = 66%				
Combined					
Production (000 metric tons)	2,474	2,647	2,021	2,637	2,030
Capacity (000 metric tons)	3,950	3,810	3,400	3,400	3,258
Capacity Utilization Rate (percent)	63%	69%	59%	78%	62%
	Average = 66%				

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the primary copper industry are described in the Development Document. The treatment options considered for this industry are as follows:

- Option B - This option includes flow reduction plus chemical precipitation and sedimentation.
- Option C - This option includes Option B plus multimedia filtration of the final effluent. One plant also includes preliminary treatment with sulfide precipitation and a filter press.

2. Costs for Existing Plants

Three plants are expected to incur costs to comply with this regulation. They include both smelters and refineries. Table IV-8 presents the investment and total annual costs for each treatment option. All of these primary copper plants are direct dischargers.

Some copper producers covered by this regulation have acid manufacturing plants located at the same site as the smelter or refinery. Both processes are subject to effluent guideline limitations in this regulation. Therefore, costs have been estimated for the acid plant and for the smelter/refinery. The two facilities are treated as a single financial entity for purposes of this impact analysis.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

The plant-specific compliance costs presented in Table IV-8 for existing sources are used to assess the probability of plant closures using the methodology presented in Chapter II. Total annual compliance costs as a percent of plant annual revenues is the screen used to identify plants that are likely to face difficulties in complying with pollution control requirements. The threshold value for this screen is 1 percent. If total annual compliance costs for a plant represent less than 1 percent of revenues, the plant is not expected to incur significant problems with its compliance costs and is not analyzed further.

The results of the screening assessment showed that only one plant had total annual compliance costs in excess of 1 percent of revenues, for both treatment options.

TABLE IV-8

PRIMARY COPPER -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs		Total Annual Costs	
	Option B	Option C	Option B	Option C
214	501,737	1,379,812	298,346	519,365
215	117,287	146,437	51,613	62,981
7001	197,546	237,008	96,317	114,077
Total	816,570	1,763,257	446,276	696,422

SOURCE: U.S. Environmental Protection Agency.

Detail may not add to totals due to rounding.

2. Plant Closure Analysis

This plant is further analyzed by using the liquidity test and the net present value (NPV) test. The liquidity test judges the short-run viability of the firm. If the pollution control expenditures cause a negative cash flow over a short period (five years), the plant does not have adequate cash reserves to meet short-term contingencies.

For the NPV test, if net income as a percent of the liquidation value of the assets (as defined in Chapter II) is less than the real cost of capital for the industry (10.14 percent), the plant will probably not continue in operation.

The results of the NPV test for the plant failing the screen show that at each option level the ratio of net income to plant liquidation value exceeded the threshold of 10.14 percent. The liquidity test showed that cash flows are expected to be positive for the short term (five years), totaling nearly $0.3 million at each option.

3. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

The financial impact of the regulatory alternatives on the primary copper industry is evaluated in terms of the increase to cost of production. This impact is measured by calculating the ratio of total annual compliance costs to total production cost. This ratio represents the percentage increase in operating costs due to the compliance expenditures. This ratio is presented below.

	Increase in Cost of Production	
	Option B	Option C
Direct Dischargers	0.08	0.12

As shown above, the increase in cost of production is not of sufficient magnitude to result in structural changes in the domestic primary copper industry.

b. Price Change

The ratio of total annual compliance cost to annual plant revenue is used to assess the maximum increase in price under the assumption of full pass-through of incremental compliance costs. The industry average for this ratio is presented below. It should be noted that in performing the screening and closure analyses, zero cost pass-through is assumed.

	Price Change	
	Option B	Option C
Direct Dischargers	0.07	0.11

If all incremental costs are passed on to consumers, prices would rise by slightly more than one-tenth of 1 percent under either option. These results are very small and indicate the potential price impact is not significant for this subcategory.

c. Change in Return on Investment

Additional environmental costs adversely affect profitability by reducing profit margins and consuming investment capital. Computed on an industry-wide basis, changes in return on investment are presented below.

	Change in Return on Investment	
	Option B	Option C
Direct Dischargers	-1.11	-1.84

As a result of compliance costs, return on investment for the primary copper industry could decline by 1.11 percent under Option B and 1.84 percent under Option C. This represents minimal impacts on the structure of the domestic industry.

d. Capital Impacts

On an industry-wide basis, investment compliance costs represent 1.07 percent and 2.31 percent of expected average industry capital expenditures under Options B and C, respectively. These results are presented below.

	Investment Cost as a % of Capital Expenditures	
	Option B	Option C
Direct Dischargers	1.07	2.31

Investment costs are shown to be a small portion of the average capital expenditures.

e. Employment Impacts

Because there are no projected closures, no adverse employment impacts are anticipated. Small production decreases, if any, caused by the higher cost of production, will not result in capacity shutdowns. Thus, employment will remain essentially unchanged by this regulation.

f. Foreign Trade Impacts

Despite the highly competitive nature of the world market for copper products, very small increases in production costs, which were discussed above, are not expected to materially reduce competition or affect the balance of trade.

CHAPTER V

PRIMARY LEAD

V. PRIMARY LEAD

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States primary lead industry of the cost of alternative pollution control technologies.

The technology used in lead production is discussed in Section B. The structure of the domestic industry, including the size, location, and ownership of the plants is presented in Section C. Lead demand characteristics and end-use markets are discussed in Section D. The current trends of the industry are discussed in Section E. Section F describes price and capacity utilization estimates. Section G presents the cost estimates for the alternative control technologies, and Section H presents the economic impact analysis.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise noted.

B. TECHNOLOGY

Lead is found in several minerals, but is found most commonly in galena (lead sulfide). Commercially viable lead ores may also be associated with certain zinc-bearing minerals. Since galena is the most common of the lead minerals, and sphalerite (zinc sulfide) is the most common of the zinc minerals, the two are often separated through selective flotation of sulfides during the milling stage. Typical analysis of a lead concentrate produced from the flotation process yields 55-70 percent lead, 6.5 percent zinc, 0.5-4 percent copper, 13-18.5 percent sulfur, 5 percent iron, and minor amounts of silica, lime, cadmium, silver, gold, arsenic, and other metals, depending on the source.

The concentrate is first roasted in air to remove sulfur, then smelted in a blast furnace or open hearth furnace with coke to reduce lead oxide to lead bullion with a purity of about 97-98 percent. At the same time, other volatile impurities are driven off in the form of gas and fume. The impurities are combined in a slag which yields additional byproduct zinc in the form of zinc oxide. The lead in the slag is returned to the furnace.

Copper is removed from lead bullion in a drossing operation whereby the bullion is heated to just above its melting point and copper dross is skimmed from the surface. The bullion is then "softened," usually through a reverberatory process. This process involves the removal of arsenic, antimony, and tin, the elements that increase the hardness of pure lead. The temperature of the lead bullion is raised and the bath is agitated to induce surface oxidation. Tin, arsenic, and antimony oxides rise to the surface with some lead oxide and are skimmed off as slag.

After softening, the lead bullion goes to the desilverization kettles. Zinc is added and forms oxide crusts (Parkes crusts), containing lead, zinc, gold and silver. The Parkes crusts are treated in the reverberatory furnace. Lead and other base metals are oxidized and slagged off, leaving silver. If gold is present, the bullion is cast into thin anodes for electrolytic parting.

The zinc remaining in the lead after desilverizing is removed by vacuum distillation. Any remaining bismuth is removed by adding an alloy. Remaining traces of zinc, arsenic, and antimony are removed in a final refining kettle by the Harris process and the lead is cast as refined bullion. The refined lead product contains more than 99.9 percent lead.

C. INDUSTRY STRUCTURE

1. Overview

The United States is one of the leading producers of primary lead. Table V-1 presents the U.S. lead industry in world perspective. The United States and the U.S.S.R., the world's principal mining countries, account for about one-third of world output, each producing about 0.6 million tons per year. Australia contributes for about 12 percent of world mine production. Canada, Peru, Mexico, and China are other important producers. Some Western European industrial countries, such as Belgium, the United Kingdom, and France do not have sufficient reserves to support a mining industry which could supply adequate feed to their lead smelters, and hence depend on imported concentrates. The relative importance of the various lead mining countries has changed in recent years, with the top ten accounting for about three-quarters of world output and the top four for about half.

Production of refined lead from ores is concentrated in those countries which have traditionally been large consumers of lead. About 59 countries report production of refined lead, but nine of them account for over 60 percent of world production. The United States, U.S.S.R., and Germany are the three largest producers of refined metal, together accounting for an estimated 40 percent of total world production. Germany and some other countries such as the United Kingdom and Japan refine imported ores and bullion; Mexico, Canada, and Australia refine a portion of their domestic ore production.

As shown in Table V-2, exports of primary lead materials have fluctuated considerably over the years. Low domestic consumption forced exports upwards from an average of about 8,000 metric tons between 1976-1979 to about 164,000 metric tons in 1980. However, the 1981 worldwide recession effected an 86 percent decline in exports. In 1982, exports rebounded by more than twice the 1981 total of 23,000 tons, to 55,000 tons.

TABLE V-1

WORLD LEAD INDUSTRY -- 1982

Country	Production				Refined Consumption	
	Mine (Thousand Short Tons)	% World	Refined (Thousand Short Tons)	% World	Thousand Short Tons	% World
United States	598.6	15.05	1,098.0	19.27	1,168.4	20.65
Australia	503.9	12.67	272.4	4.78	103.6	1.83
U.S.S.R.	628.3	15.80	881.8	15.481	881.8	15.58
Other	2,245.9	56.47	3,443.4	60.45	3,502.0	61.92
Total	3,976.7	100	5,695.9	100	5,655.8	100

SOURCE: Non-Ferrous Metals Data -- 1982,
American Bureau of Metal Statistics, Inc.

TABLE V-2

U.S. IMPORTS AND EXPORTS OF PRIMARY LEAD

(thousand metric tons)

Year	Imports	Exports	Net Exports (Imports)
1971	175	5	(170)
1972	223	8	(215)
1975	90	19	(71)
1978	225	8	(217)
1979	183	11	(172)
1980	81	164	83
1981	100	23	(77)
1982	90	55	(35)

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983, and American Bureau of Metal Statistics, 1982.

2. Primary Smelting and Refining Plants

Primary smelters use both domestic and imported concentrates as raw material. Some scrap is also consumed by primaries but only in very small amounts. Primaries produce soft (refined) lead, the bulk of which is used in batteries or gasoline (as tetraethyl lead (TEL)). The primaries also produce small amounts of hard (antimonial) lead.

Lead smelters tend to be located near mines and can be differentiated as either Missouri or non-Missouri smelters. Missouri lead ores contain small amounts of byproduct zinc, coproduct copper, silver, nickel, and cobalt. Smelters treating Missouri ores have been constructed to handle only low levels of these impurities and, consequently, cannot utilize western ores with their much higher impurity levels. Non-Missouri smelters have much more extensive refining facilities and handle the higher byproduct levels found in more complex western and imported ores.

3. Description of Plants

Table V-3 lists the three primary lead producers in the U.S. These companies operate five smelters and four refineries. They are large, integrated, multiplant companies producing a variety of nonferrous metals and other products. They are generally not integrated into fabrication, although there are some specific exceptions.

Asarco, Inc. operates lead smelters at El Paso, Texas, East Helena, Montana, and Glover, Missouri, and a lead refinery in Omaha, Nebraska, which refines the lead bullion from El Paso and East Helena. Asarco is extensively integrated horizontally with various plants and divisions smelting and refining a large number of metals including lead, zinc, copper, a variety of precious metals, and high-purity metals. Asarco is integrated back to the mine level but acquires most of its concentrate on a custom or toll basis. In 1976, only 6 percent of the lead produced by Asarco was from its own mines. Asarco's Federated Metals Corporation also produces lead and other metals and alloys from secondary materials. Asarco also operates some fabrication facilities. In metal processing, Asarco is an almost completely self-contained operation. Lead residues from copper smelters are processed at either El Paso or East Helena. The El Paso and Hayden (Arizona) copper smelters send lead-bearing residues to the El Paso lead smelter, while lead-bearing materials from the Tacoma copper smelter are sent to East Helena. Glover's production is principally on a custom basis from Missouri producers, because it is designed to handle the higher purity concentrates found in the Missouri New Lead Belt.

The smelter at Buick, Missouri, is a joint venture of Amax, Inc. and Homestake Mining Company. Half of the capacity at Buick is committed on a tolling contract to an outside source of concentrates. The remainder is used to treat concentrate from the Amax-Homestake mine.

St. Joe Minerals is also an integrated producer. It operates a lead smelter in Herculaneum, Missouri, which is almost totally self-

TABLE V-3

LEAD SMELTERS/REFINERS -- 1982

Company	Location	Facility	Annual Capacity (Thousand Short Tons)
Asarco, Inc.	Omaha, NE	Refinery	180[a]
	East Helena, MT	Smelter	420[b]
	El Paso, TX	Smelter	420[b]
	Glover, MO	Smelter/Refinery[c]	110[a]
Amax-Homestake	Buick, MO	Smelter/Refinery[c]	140[a]
St. Joe Lead Co.	Herculaneum, MO	Smelter/Refinery[c]	225[a]

SOURCE: Non-Ferrous Metals Data -- 1982,
American Bureau of Metal Statistics, Inc.

[a] Refined lead capacity.

[b] Charge capacity.

[c] Limited to the refining of Missouri concentrates.

sufficient on company production of lead concentrate from its Missouri lead mines. St. Joe occasionally does some custom smelting, and is forward integrated into rolling.

D. LEAD DEMAND

Lead consumption by end use is presented in Table V-4.

1. Batteries

Batteries are lead's largest single demand sector, accounting for about 65 percent of all lead consumed in 1982. Most of the lead used for batteries is in small starting, lighting, and ignition (SLI) batteries. The development of low antimony (less than 1 percent Sb) and antimony-free or "maintenance-free" (MF) batteries has resulted in a substantial increase in the demand for soft lead. Lead consumption in batteries in 1982 fell 12 percent from the 1981 level, and 23 percent from the 1978 level. The fall was due to the substantial decline in new car sales and the fact that less lead is used in new batteries.

2. Chemicals

The chemicals industry is the second largest demand sector for lead. In 1982, this sector accounted for about 11 percent of total lead consumption. Tetraethyl lead (TEL) and, to a lesser extent, tetramethyl lead (TML) are used as anti-knock additives in gasoline production. Current regulations allow gasoline producers to add 0.5 grams of lead per gallon for both leaded and unleaded gasoline combined. While this was intended to reduce the use of lead as a gasoline additive, lead use in TEL rose 7 percent from 1981 to 1982. This surprising result was due to a significant increase in unleaded gasoline production, which allowed producers to add more lead to their leaded product. However, EPA's proposed lead-in-gasoline regulations would limit the use of lead to 1.1 grams per gallon of leaded gasoline, and thus prevent gasoline producers from adding more lead to leaded gasoline as their product mix changes to the production of more unleaded gasoline.

3. Pigments

Lead use in pigments, primarily in the form of litharge and red lead, declined about 20 percent to 70,000 short tons, reflecting depressed demand from the construction sector. Pigments accounted for 6 percent of lead consumption in 1982.

4. Ammunition

Ammunition accounted for 4 percent of lead consumption in 1982. Ammunition consumption as a percentage of total lead consumption remained steady between 1978-1982. However, in absolute terms, the use of lead for this purpose is on the decline. Lead alloy with 2-6 percent antimony and up to 1 percent arsenic is used in bullet cores and shot. Lead chemicals in the form of lead azide are also used in the manufacture of ordnance materials.

TABLE V-4

LEAD CONSUMPTION IN THE UNITED STATES BY END-USE MARKETS

(thousand short tons)

	1978	1979	1980	1981	1982
Metal Products					
Ammunition (shots and bullets)	61	59	54	55	47
Batteries	969	898	711	849	743
Other metal products[a]	208	203	168	148	130
Pigments	101	100	86	88	70
Chemicals-Petroleum Refining	197	206	141	123	131
Miscellaneous uses	43	32	20	24	24
Total	1,579	1,498	1,180	1,287	1,145

SOURCE: Non-Ferrous Metals Data -- 1982,
American Bureau of Metal Statistics, Inc.

[a] Other metal products include bearing metals, cables, building construction, casting metals, pipes, traps, sheet lead, solder lead, and term lead.

5. Other Metal Products

The use of lead in this category declined about 12 percent from the 1981 level of 148,000 short tons, owing not only to the slump in the construction sector but also to increased substitution by plastics, aluminum, tin, and iron in building construction, electrical cable covering, and cans and other containers.

6. Miscellaneous

Miscellaneous uses accounted for about 2 percent of total lead consumption between 1978-1982.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

The United States relies on three main sources of lead supply: primary production, secondary recovery, and imports. Annual production of primary lead has been relatively stable in the range of 500,000-600,000 metric tons. Development of Missouri's New Lead Belt has reduced U.S. reliance on foreign lead ores and concentrates. Over 95 percent of all domestic primary lead now comes from low-cost, high-yield Missouri mines that are owned and operated by highly integrated producers. This production has resulted in a relatively constant capacity in the primary lead sector.

The annual U.S. producer price for lead reached a high of 52.7 cents per pound in 1979, the most recent high demand year. Low 1982 prices, 25.5 cents per pound, were attributed to generally poor overall economic conditions. The U.S. producer price is usually 2.5-3 cents per pound higher than the London Metal Exchange (LME) settlement price, which equates the cost of ocean freight, import duties, and dock charges, to be competitive in the U.S. market.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed for purposes of this analysis, that plants engaged in the production of lead will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the 1978-1982 period. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the lead industry.

As discussed in the previous section, U.S. producer prices have historically been close to LME prices. Both lead smelters and refiners are included in this analysis. The product prices used correspond to the specific production activity (i.e., smelting or refining). The price of refined lead used for this analysis, $906.32 per ton (see Table V-5), is based on U.S. producer list prices. The price at which smelters sell lead to refiners is not quoted in the market. Hence, the price for smelted lead is computed on the basis of the ratio of the smelting capacity to refined capacity. It is also assumed that refiners contribute 10 percent to the value of the product. The average price of

TABLE V-5

AVERAGE ANNUAL U.S. PRODUCER PRICE OF LEAD

Year	Cents per Pound		1982 Dollars per Ton
	Actual	1982 Dollars	
1978	33.7	46.43	928.60
1979	52.7	66.79	1,335.80
1980	42.4	49.17	983.40
1981	36.5	38.69	773.80
1982	25.5	25.50	510.00
		Average price =	$906.32

SOURCE: *Mineral Commodity Profiles*,
U.S. Department of the Interior,
Bureau of Mines, 1983.

refined lead for the 1978-1982 period is, therefore, $906.32 x 0.21 x 0.9 = $171.29 per ton. Data on the ratio of smelting to refining capacity and the value added at smelters were obtained from the Department of Commerce's Bureau of Census (1977 Census of Manufactures).

The capacity utilization rate is 76 percent (see Table V-6). For both prices and utilization rates, the values used in the analysis show improvement over 1982. This is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM), which shows an overall improvement in the primary lead industry. Specifically, the BOM projects primary lead demand to increase at an annual average rate of 2 percent from 1981 to 2000. (Mineral Commodity Profiles, Bureau of Mines, 1983).

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the primary lead industry are described in the Development Document. The treatment options considered for this industry are as follows:

- Option A - This option includes equalization, chemical precipitation, and gravity settling.
- Option B - This option includes Option A plus flow reduction of all scrubber wastestreams via a holding tank and recycle system before lime and settle.
- Option C - This option includes Option B plus sulfide precipitation, gravity sedimentation, and multimedia filtration of the final effluent.

2. Costs for Existing Plants

The compliance costs for three levels of treatment are analyzed for this industry. The compliance cost estimates developed for each of the plants for each level of control are presented in Table V-7. Some lead producers covered by this regulation have acid manufacturing plants located at the same site as the smelter or refinery. Both processes are subject to effluent guideline limitations included in this regulation. Costs have been estimated for both the acid plant and the smelter/ refinery and the combined costs are applied to a facility with both activities. For purposes of this impact analysis, the two processes at one location are treated as a single financial entity.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

The plant-specific compliance costs for the alternative control technologies for each plant are evaluated against anticipated revenue. The total annual compliance cost (consisting of operating and

TABLE V-6

PRIMARY LEAD INDUSTRY - CAPACITY UTILIZATION

Year	Refined Metal Production (thousand metric tons)	Capacity (thousand metric tons)	Capacity Utilization (%)
1978	568.1	714	80
1979	578.2	714	81
1980	548.4	714	77
1981	498.3	714	70
1982	516.8	714	72
	Average capacity utilization = 76%		

SOURCE: Mineral Commodity Profiles and Mineral Industry Survey, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE V-7

PRIMARY LEAD -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs			Total Annual Costs		
	Option A	Option B	Option C	Option A	Option B	Option C
Direct Dischargers						
1	39,325	39,325	42,762	10,047	10,047	12,441
286	18,975	18,975	18,975	2,287	2,287	2,287
288	55,687	164,312	341,137	14,630	45,310	105,949
290	97,212	127,187	356,675	28,647	39,219	119,731
Subtotal	211,199	349,799	759,549	55,611	96,863	240,407
Indirect Dischargers						
284	18,975	18,975	18,975	2,287	2,287	2,287
4502	18,975	18,975	18,975	2,287	2,287	2,287
Subtotal	37,950	37,950	37,950	4,574	4,574	4,574
Total	249,149	387,749	797,499	60,185	101,437	244,981

SOURCE: U.S. Environmental Protection Agency.

Detail may not add to total because of rounding.

maintenance costs, and annualized capital costs), is evaluated against an estimate of plant revenues, which is based on the subcategory price and capacity utilization rate. If the compliance cost represents more than 1 percent of anticipated revenue, the plant is considered for further analysis.

The results of the screening assessment show that no plant had total annual pollution control costs exceeding 1 percent of anticipated revenues. Even under the most costly alternative for all dischargers, the maximum pollution control cost is only about 0.1 percent of anticipated total annual revenues. Since no lead plants violated the screening analysis, there are no expected plant closures in this industry due to this regulation. These results support a conclusion that the compliance costs are not significant for this subcategory.

2. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

The effect of compliance with the regulatory alternatives on the financial performance of the primary lead industry is evaluated in terms of the increase in cost of production. The primary lead industry is expected to incur relatively low annual and investment costs; therefore, the cost of production does not increase to a significant extent. As shown in the table below, the increase in cost of production varies from 0.01 percent under Option A to 0.06 percent under Option C for direct dischargers. For indirect dischargers, the increase in the cost of production is less than 0.01 percent.

	Increase in Cost of Production		
	Option A	Option B	Option C
Direct Dischargers	0.01	0.02	0.06
Indirect Dischargers[a]	--	--	--

[a] Less than 0.01 percent.

b. Price Change

The results of the screening assessment (total annual compliance costs as a percentage of total revenue) presented above have been used to assess the maximum increase in price under the assumption of full pass-through of incremental costs. Therefore, if all incremental costs were passed on to consumers, the maximum price increase will be approximately 0.05 percent. The following table shows the maximum price increase under each option. It should be noted that in performing the screening and closure analysis, zero cost pass-through is assumed.

	Price Change		
	Option A	Option B	Option C
Direct Dischargers	0.01	0.02	0.05
Indirect Dischargers[a]	--	--	--

[a] Less than 0.01 percent.

The price increase for the direct dischargers would range from 0.01 percent under Option A to 0.05 percent under Option C. For the indirect dischargers, the price increase associated with compliance costs would be less than 0.01 percent. These increases are small and would not constitute a significant impact on the domestic industry.

c. Change in Return on Investment

As a result of the increased capital requirements for pollution control, the overall profitability of the primary lead industry, in terms of operating margin on investment, is estimated to decrease by less than 1 percent even at the most costly option.

The following table shows the change in the return on investment (ROI) for the primary lead industry.

	Change in Return on Investment		
	Option A	Option B	Option C
Direct Dischargers	-0.23	-0.40	-0.95
Indirect Dischargers	-0.10	-0.10	-0.10

These changes in ROI are very small and do not indicate a significant effect on profitability for these facilities.

d. Capital Impacts

The additional capital investment for compliance with the regulatory options for each of the primary lead plants is shown below. These costs have been compared to the average investment expenditures of lead plants.

	Investment Cost as a % of Capital Expenditures		
	Option A	Option B	Option C
Direct Dischargers	0.39	0.65	1.42
Indirect Dischargers	0.29	0.29	0.29

The table shows that incremental cost is no more than 1.42 percent of capital expenditures, even under the most costly option. The impacts on capital expenditures, therefore, are not expected to be significant.

e. Employment Impacts

Employment effects of the regulatory costs are examined in the context of plant closures. Since no plant closures have been identified in the primary lead industry, it is estimated employment will experience no adverse effects as a result of this regulation. Small production decreases, if any, caused by the regulatory-induced higher cost of production, will not result in capacity shutdowns. Thus, with minimal changes in prices or production, employment will remain essentially unchanged.

f. Foreign Trade Impacts

The economic impact of the compliance costs on the balance of payments is studied in relation to domestic price and production. As shown above, no significant increase in price has been estimated. Similarly, it is assumed that domestic production will not be hampered by the regulatory costs. With negligible changes in price and production, there will not be any general increase in imports. Thus, the balance of trade will not be affected by the regulations.

CHAPTER VI

PRIMARY ZINC

VI. PRIMARY ZINC

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States primary zinc industry of the cost of alternative pollution control technologies.

The technology used in zinc production is discussed in Section B. The structure of the domestic industry, including the size, location and ownership of the plants, is presented in Section C. Zinc demand characteristics and major end-use markets are discussed in Section D, and the current trends of the industry are discussed in Section E. Estimates of prices and capacity utilization are presented in Section F. Section G presents the cost estimates for the alternative control technologies and relates the control technologies to three regulatory options. Section H presents the results of the economic impact analysis.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise indicated.

B. TECHNOLOGY

Zinc ore occurs in nature most abundantly as a sulfide. The deposits usually contain some lead associated with lesser quantities of iron and copper sulfides. The sulfides are separated from the waste and, to a certain extent, from each other by differential flotation. A typical zinc concentrate prepared for smelting may contain 52-60 percent zinc, 30-33 percent sulfur, and 4-11 percent iron. There is also a small amount of lead and minor quantities of cadmium, copper, and other metals.

The concentrate is first roasted to oxidize the sulfur-bearing zinc minerals. The roasting typically converts more than 90 percent of the sulfur to sulfur dioxide, which can then be used to dissolve the zinc contained in the ore to produce zinc sulfate. The reduction of the roasted concentrate may be accomplished in two ways: by electrolytic deposition from a sulfate solution; and by distillation in retorts or furnaces.

At electrolytic plants, the roasted zinc concentrate is leached with dilute sulfuric acid to form a zinc sulfate solution. The solution is then purified and piped to electrolytic cells, where the zinc is electrodeposited on aluminum cathodes. The cathodes are lifted from the tanks at intervals and stripped of the zinc. At a pyrometallurgical smelter, the roasted concentrate is mixed with coke and heated to reduce the zinc oxide to zinc metal. During the hot smelting of the coke-concentrate mixture in furnaces called retorts, the zinc metal vaporizes and is collected in cooled condensers. In both methods, the refined metal is cast into slabs.

C. INDUSTRY STRUCTURE

1. Overview

The United States was the principal world mine producer of zinc until the mid-1960s when Canada became the world's leading zinc producer. Domestic mine production declined almost continuously from 1971 to 1982.

U.S. imports and exports are listed in Table VI-1. As shown in the table, the United States has been historically dependent upon imports of concentrates for a substantial portion of smelter feed. However, the need for foreign concentrates has declined significantly because of the substantial reduction in smelting capacity. This has resulted in an increase in zinc imports to meet the demand for finished metal. Imports of metal rose by 52 percent between 1969-1982.

2. Domestic Smelters

Several large, vertically integrated firms with mines, smelters, and refineries are prominent in the domestic primary zinc industry. The principal zinc smelters that operated in 1982 are listed in Table VI-2. All of the plants are fairly large, with the smallest at 56,000 tons and the largest at 114,000 tons of zinc metal.

D. ZINC DEMAND

Table VI-3 shows the major end-use markets for zinc. Die casting and galvanized steel constitute the two major markets of U.S. zinc consumption -- over 70 percent. Zinc is also used as a component of brass and bronze, and in smaller quantities by the paint, rubber, ceramics, and chemical industries. Approximately 500 firms in Illinois, Indiana, New York, Ohio, and Pennsylvania account for about 50 percent of total consumption.

1. Galvanized Steel

Zinc use in steel galvanizing continues to be the largest demand sector, accounting for slightly more than 50 percent of slab zinc consumption in 1982. The slump in construction activity and low automobile production caused zinc consumption for galvanized steel to fall to 367,000 tons -- a 19 percent decline from the previous year. In addition, alternatives to galvanizing, such as aluminum and plastics, are now competing with zinc for these markets. Galvalume, which consists of 55 percent aluminum, 43.3 percent zinc, and 1.6 percent silicon alloy is making inroads on conventional galvanizing of sheet and strip steel. However, a new galvanizing alloy composed of 95 percent zinc and 5 percent aluminum may be competitive with Galvalume in some uses.

TABLE VI-1

U.S. IMPORTS AND EXPORTS OF ZINC

(thousand metric tons of zinc content)

Year	Imports of Metal	Imports of Ore and Concentrates	Exports of Metal	Exports of Ore and Concentrates
1969	295	546	8	--[a]
1972	474	231	4	--[a]
1973	537	181	13	--[a]
1974	489	218	17	--[a]
1975	345	132	6	--[a]
1976	648	88	3	--[a]
1978	618	188	1	11
1979	527	225	--[b]	20
1981	603	118	--[b]	54
1982	447	49	--[b]	77

SOURCE: Mineral Facts and Problems, U.S. Department of the Interior, Bureau of Mines, 1983.

[a] Not available.

[b] Less than 0.5 thousand metric tons.

TABLE VI-2

PRIMARY ZINC SMELTERS -- 1982

Name of Company	Location	Method	Rated Capacity (short tons/yr)	Year First Operated
Asarco, Inc.	Corpus Christi, TX	Electrolytic	114,000	1941
Amax Zinc Co.	Sauget, IL	Electrolytic	84,000	1941 (rebuilt 1973)
National Zinc Co.	Bartlesville, OK	Electrolytic	56,000	1977
St. Joe Zinc Co.	Monaca, PA	Pyrometallurgical	82,000	1938
Jersey-Miniere	Clarksville, TN	Electrolytic	90,000	1978
Total			412,000	

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics.

TABLE VI-3

1982 U.S. SLAB ZINC CONSUMPTION BY END USE

(in percentages)

End Use	Share
Galvanizing	50
Die casting alloys	28
Brass and bronze	11
Zinc oxide	3
Other uses[a]	8
Total	100

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics, Inc.

[a] Includes zinc used for zinc dust, wet batteries, desilverizing lead, light-metal alloys, and other uses.

2. Die Castings

Zinc die castings are suitable for components having complex shapes that require good mechanical properties, close dimensional accuracy, and corrosion resistance. This sector accounted for about 28 percent of zinc consumption in 1982. Zinc use by this sector, primarily in the automotive industry, has declined substantially because of substitution by plastics, particularly ABS (acrylonitrile butadiene styrene) and other metals, as well as automotive downsizing.

3. Brass and Bronze

Brass and bronze (5-40 percent zinc content) accounted for 11 percent of slab zinc consumption in 1982. Brass and bronze alloys are highly sensitive to overall economic activity rather than to one or two industries, because they are used by many economic sectors. Aluminum alloys are being substituted increasingly for brass and bronze alloys.

4. Zinc Oxide

A small percentage of zinc is consumed in the form of oxides. About 3 percent of the zinc consumed in 1982 went into this sector. Zinc oxides are produced from zinc concentrates, slab zinc, and scrap, and are used extensively in the rubber industry and in making white paint and pigments.

5. Other Uses

The decision of the U.S. Treasury in 1981 to replace the old penny, made from 95 percent copper and 5 percent zinc, with a new penny, made from 98 percent zinc with a 2 percent copper coating, created a major new market for zinc. This decision was made because the price of zinc is significantly lower than the price of copper. The production of the penny during 1982 used about 15,000 tons of zinc. Other uses of zinc accounted for 8 percent of zinc consumption in 1982.

E. CURRENT TRENDS — CAPACITY UTILIZATION AND PRICES

The economic recession that characterized the U.S. automotive and construction industries in 1982 had a severe impact on the domestic zinc industry. Throughout the year, zinc refineries operated at substantially reduced levels, and some closed entirely for several months. Capacity utilization fell from 72 percent in 1981 to 46 percent in 1982.

Because zinc is an internationally traded commodity, its price is determined in the world marketplace. There are three main price quotations for zinc: the U.S. producers' price, the European producers' price (EPP), and the London Metal Exchange (LME) price. The U.S. producers' price is based on High Grade zinc and reflects a weighted average of prices charged by individual North American producers. The EPP, instituted in 1964 by major European, Canadian, and Australian producers, is quoted for Good Ordinary Brand (GOB) zinc. The LME price is a free-market price. Although the LME price covers less than 10 percent of the world market for zinc, it exerts a strong influence on producers' prices. Both U.S. producers' and European producers' prices are generally higher than the LME price. Major U.S. producers still market the bulk of their product on a producer price system and buy what zinc concentrates they need on the same price basis, but many smaller smelting companies and zinc mining companies without smelting facilities trade their material on LME prices. U.S. producers cannot allow their producer price to stray too far from the free market price. If the price is set too high, zinc would flood in from outside the U.S.; if the price is too low, margins fall. The latter situation occurred in the period 1971-1973 when the economic stabilization program froze the price of zinc at 17 cents per pound. The LME price then was quoted very high -- at one time over 99 cents per pound. Foreign smelters took the advantage and outbid U.S. producers. From the mid-1970s until 1981, the price of zinc rose steadily; in 1981 it attained a level of 45 cents per pound. Weak markets in 1982, however, depressed the price. By midyear, the price had fallen to 35 cents per pound, but recovered to 38 cents per pound by the end of the year, mainly due to a combination of production cutbacks, strikes in Canada, and declining inventories.

The price recovery that occurred in the second half of 1982 is expected to continue. Zinc demand will be supported by an increase in motor vehicle production and the expected upturn in new construction.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the production of zinc will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the period 1978-1982. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the zinc industry.

The zinc price used for this analysis is based on U.S. producer list prices. As discussed in the previous section, U.S. producer prices have been generally close to LME prices. The price of refined zinc produced at both refineries and smelters for the analysis is $876.20 per ton (see Table VI-4). The capacity utilization rate is 60 percent (see Table VI-5). For both prices and utilization rates, the values used in the analysis show improvement over 1982. This is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM) which shows an overall improvement in the primary zinc industry. Specifically, the BOM projects primary zinc demand to increase at annual average rate of 2 percent from 1981 to 2000 (Mineral Commodity Profiles, Bureau of Mines, 1983).

TABLE VI-4

AVERAGE ANNUAL U.S. PRODUCER PRICE OF ZINC

Year	Cents per Pound		1982 Dollars per Ton
	Actual	1982 Dollars	
1978	30.97	42.67	853.40
1979	37.30	47.27	945.40
1980	37.43	43.41	868.20
1981	44.56	47.23	944.60
1982	38.47	38.47	769.40
			Average = 876.20

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE VI-5

CAPACITY UTILIZATION RATES FOR DOMESTIC PRIMARY PRODUCERS

Year	Production (000 Metric Tons)	Capacity (000 Metric Tons)	Capacity Utilization (Percent)
1978	407	716	57%
1979	472	720	66%
1980	340	575	59%
1981	347	484	72%
1982	228^{p}	493	46%
			Average = 60%

SOURCE: *Mineral Commodity Profiles*, U.S. Department of the Interior, Bureau of Mines, 1982.

^{p}Preliminary.

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the primary zinc industry are described in the Development Document. The treatment options considered for this industry are as follows:

- Option B - This option includes flow reduction of all scrubber wastestreams via a holding tank and recycle system before lime and settle.
- Option C - This option includes Option B plus sulfide precipitation, gravity sedimentation, and multimedia filtration of the final effluent.

2. Costs for Existing Plants

Five primary zinc plants are expected to incur costs for compliance with this regulation. These five plants represent approximately 80 percent of the total industry capacity. The total annual and investment compliance costs for these five plants, for each treatment option, are presented in Table VI-6.

Some zinc producers covered by this regulation have acid manufacturing plants located at the same site as the smelter or refinery. Both processes are subject to effluent guideline limitations in this regulation. Therefore, costs have been estimated for both the acid plant and the smelter/refinery. The two facilities are treated as a single financial entity for purposes of this impact analysis.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

The plant-specific compliance costs are used to assess the probability of plant closures using the methodology presented in Chapter II. The screening analysis identifies plants for which the compliance costs may be significant. The screening analysis is based on total annual compliance costs as a percent of annual revenues. The threshold value for this screen is 1 percent. If total annual compliance costs for a plant are less than 1 percent of revenues, the plant is assumed not to face difficulties with compliance costs and is not analyzed further. Under the most stringent option reviewed, estimated total annual costs did not exceed 0.34 percent of anticipated annual revenues for any plant. Since no zinc plants violated the screening analysis, there are no expected plant closures in this industry due to this regulation. These results indicate that compliance costs do not represent a significant economic impact for this subcategory.

TABLE VI-6

PRIMARY ZINC -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs		Total Annual Costs	
	Option B	Option C	Option B	Option C
Direct Dischargers				
279	92,125	399,712	32,772	124,499
281	85,387	340,312	26,891	100,389
283	56,925	352,412	27,793	138,895
9060	31,075	260,562	16,260	82,336
Subtotal	265,512	1,352,998	103,717	446,120
Indirect Discharger				
278	18,975	283,250	15,697	93,358
Total	284,487	1,636,248	119,414	539,478

SOURCE: U.S. Environmental Protection Agency.

Detail may not add to total due to rounding.

2. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

This impact is measured by calculating the ratio of total annual compliance costs to the total cost of operations. The cost of operations is assumed to equal annual revenues minus operating income of a plant. This ratio represents the percent increase in operating costs due to the compliance expenditures. For the primary zinc industry, the average increases are shown below.

	Increase In Cost of Production	
	Option B	Option C
Direct Dischargers	0.06	0.27
Indirect Dischargers	0.04	0.23

It can be seen by this analysis that the annual costs due to this regulation will increase operating costs by no more than 0.27 percent for any treatment option. This is not expected to significantly affect the domestic zinc industry.

b. Price Change

This change is expressed as the ratio of total annual compliance costs to total plant revenues. This ratio represents the percent increase in price a plant would have to impose to pass through the entire cost of these regulations. The average price increases are shown below. It should be noted that for the screening and closure analyses, zero cost pass-through is assumed.

	Price Change	
	Option B	Option C
Direct Dischargers	0.06	0.25
Indirect Dischargers	0.04	0.21

A maximum price increase of 0.25 percent would be required to pass through the entire cost of these regulations for the primary zinc industry. This amount is small and would not be expected to adversely affect the industry.

c. Change in Return on Investment

Return on investment (ROI) is expressed as net income divided by total assets. For this regulation, the change in ROI is as follows:

	Change in Return on Investment	
	Option B	Option C
Direct Dischargers Indirect Dischargers	-0.98 -0.54	-4.34 -3.70

Rates of return on investment for the industry are expected to decrease by between 0.54 percent and 4.34 percent. These declines represent a minimal impact on the profitability of the zinc industry.

d. Capital Impacts

For the primary zinc industry, the average ratios of investment costs to capital expenditures are as follows:

	Investment Cost as a % of Capital Expenditures	
	Option B	Option C
Direct Dischargers Indirect Dischargers	1.24 0.36	6.33 5.40

These results show that primary zinc plants will incur costs due to this regulation of between 0.36 percent and 6.33 percent of their average annual capital expenditures. Impacts of this magnitude are not expected to affect plants' ability to raise capital for compliance equipment.

e. Employment Impacts

Because there are no projected closures, no adverse employment impacts are anticipated. Small production decreases, if any, caused by the higher cost of production, will not result in capacity shutdowns. Thus, employment will remain essentially unchanged by this regulation.

f. Foreign Trade Impacts

Despite the highly competitive nature of the world market for zinc products, the very small increases in production costs, as discussed above, are not expected to materially reduce competition or affect the balance of trade.

CHAPTER VII

SECONDARY ALUMINUM

VII. SECONDARY ALUMINUM

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States secondary aluminum industry of the cost of alternative pollution control technologies.

The technology used to produce aluminum from scrap is briefly discussed in Section B. The structure of the industry is presented in Section C. Section D discusses aluminum demand and end-use markets. Section E describes current trends in the industry, and Section F presents price and capacity utilization estimates. Section G discusses the cost estimates for the alternative control technologies. The results of the analysis are presented in Section H.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise noted.

B. TECHNOLOGY

The secondary aluminum industry produces metallic aluminum from aluminum scrap in four broad stages:

1) The scrap material is upgraded by either dry or wet milling operations to separate the metallic aluminum from the non-metallic.

2) Feed material, after being cleaned to remove tramp metals (e.g., iron) and oil or grease (primarily from bearings and turnings), is charged to the furnace and melted. Primary ingot, a high purity scrap, is added to the melt to reduce impurity levels to the desired specification.

3) The slag is then skimmed off and fluxed to retard oxidation. Copper, silicon, or zinc are added to bring the melt up to specification. Magnesium is removed from the melt by the addition of chlorine. Magnesium reacts with chlorine and floats to the surface of the melt where it combines with the fluxing agent and is skimmed off.

4) The adjusted metal is degassed by bubbling dry nitrogen, chlorine, or a mixture of the two gases through the molten metal bath. It is then cast into ingots or transported as liquid metal in insulated ladles.

C. INDUSTRY STRUCTURE

1. Overview

The United States is a significant producer of secondary aluminum. Historically, the secondary smelting industry has accounted for approximately one-quarter of total aluminum production (see Table VII-1). Despite recessionary conditions in 1980-1982, production of secondary aluminum has been increasing, reaching 2,124,000 short tons in 1982, which was about 37 percent of total aluminum production. Rising energy costs in recent years have resulted in increased recovery of secondary aluminum because production of secondary aluminum requires only about 5 percent as much energy as does aluminum production from bauxite (i.e., primary). The amount of aluminum (in millions of pounds) recovered from recycled cans has increased from 360 in 1979 an estimated 1,140 in 1982, due to a dramatic increase in the use of aluminum cans for beer and soft drinks in the last ten years. In 1981, 95 percent of all beer cans and 74 percent of all soft drink cans, or 85 percent of the total market, were aluminum cans.

As shown in Table VII-2, the United States has been a net exporter of scrap; in 1980, exports of scrap material peaked at 444,681 short tons. In 1981, worldwide recessionary conditions, as well as increased recovery of aluminum in the domestic market, resulted in a sharp decline in scrap exports. In 1981, 241,162 short tons of aluminum scrap were exported, compared with imports of 81,994 short tons. Of the total exports, 73 percent went to Japan, while 82 percent of total imports came from Canada. Scrap exports were about 11 percent less in 1982 than in 1981; imports were about 9 percent less.

2. Description of Plants

Many firms in the secondary aluminum industry have one plant and are either family-owned or owned by small corporations. The integration level of these firms is generally low. However, a minority of firms, which represent a large portion of production, are large corporations or subsidiaries of large corporations and are generally multiplant operations. Most smelters buy aluminum scrap and smelt and refine it to hot metal and billets. Foundries and extruders consume these semi-finished products. Other secondary products are de-oxidizing materials (notched bar and shot) which are used in steel mills.

A small segment of the industry consumes billet-grade aluminum scrap for the manufacture of extrusion billets. Most of the billet manufacturers are forward-integrated. They commonly produce semi-finished and finished products (such as extrusions) and building construction items (such as doors, windows, and storm doors).

Most plants currently producing secondary aluminum metal are located near heavily industrialized areas in order to have access to a good supply of scrap and also to customers. These plants are chiefly located in or near the Chicago, Cleveland, and Los Angeles metropolitan areas. Approximately 35 percent of U.S. secondary aluminum production

TABLE VII-1

U.S. PRIMARY AND SECONDARY ALUMINUM PRODUCTION

(thousands of short tons)

Year	Total Production	Primary Production	Secondary Recovery[a]	Secondary Production As a Percentage of Total Production
1968	4,285	3,255	1,031	24.1
1970	5,009	3,976	1,033	25.3
1973	5,759	4,529	1,230	21.4
1975	5,115	3,879	1,236	24.2
1978	6,477	4,804	1,673	25.8
1979	6,800	5,023	1,777	26.1
1980	6,868	5,130	1,738	25.3
1981	7,003	4,948	2,055	29.3
1982	5,733	3,609	2,124	37.0

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics, Inc.

[a] Includes both new and old scrap.

TABLE VII-2

U.S. IMPORTS AND EXPORTS OF ALUMINUM SCRAP

(short tons)

Year	Imports	Exports	Net Exports (Imports)
1978	92,153	194,508	102,355
1979	68,316	307,080	238,764
1980	59,802	444,681	384,879
1981	81,994	241,162	159,168
1982	74,388	214,299	139,911

SOURCE: Non-Ferrous Metals Data -- 1982,
American Bureau of Metal Statistics, Inc.

is done within a 100-mile radius of downtown Chicago. Within a similar radius of Cleveland, another 20 percent of the production can be found. The remaining 45 percent is located near Los Angeles, New York City, and Philadelphia.

D. ALUMINUM DEMAND

Demand for aluminum is independent of the production source, whether primary or secondary. Cans and containers, transportation, and construction are the major end-use markets for aluminum. For a description of these markets and demand patterns for the aluminum industry as a whole, see Chapter III, Section D.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

Secondary aluminum production is an important part of the aluminum industry, especially following recent, substantial increases in electric power rates. Since 1979, power rates have increased 750 percent in the Pacific Northwest, where one-third of the U.S. primary aluminum industry is located. According to a survey conducted by the American Metal Market in 1981, the capacity to produce aluminum from old scrap was about 1.13 million metric tons.

Secondary aluminum prices are generally the same as primary aluminum prices. Differences do exist, but are usually only a function of purity levels. Secondary aluminum list prices are not applicable to this analysis because premiums and discounts are commonly applied. Further, these list prices do not provide a reliable indication of actual transaction prices. Therefore, primary aluminum prices are used in the following analysis.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the secondary production of aluminum will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the period 1978-1982. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the secondary aluminum industry.

The aluminum price for the analysis is $1,567.08 per ton (see Table VII-3). The capacity utilization rate is 63.13 percent (see Table VII-4). For both prices and utilization rates, the values used in the analysis show improvement over 1982. This assessment is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM), which shows an overall improvement in the secondary aluminum industry. Specifically, the BOM projects secondary aluminum demand to increase at an average annual rate of 7 percent from 1981 to 2000. (Mineral Commodity Profiles, Bureau of Mines, 1983).

TABLE VII-3

U.S. ALUMINUM PRICES

Year	Cents per Pound		1982 Dollars per Ton
	Actual	1982 Dollars	
1978	54	74.40	1,488.00
1979	61	77.32	1,546.40
1980	72	83.49	1,669.80
1981	76	80.56	1,611.20
1982	76	76.00	1,520.00
		Average price =	1,567.08

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Census, 1983.

TABLE VII-4

CAPACITY UTILIZATION RATES[a]

Year	Production (thousand metric tons)	Capacity[b] (thousand metric tons)	Capacity Utilization (percent)
1978	575	1,130	50.88%
1979	614	1,130	54.34
1980	680	1,130	60.18
1981	836	1,130	73.98
1982	862	1,130	76.28
	Average capacity utilization =		63.13%

SOURCE: Production data -- Mineral Commodity Profiles, and Mineral Industry Survey, U.S. Department of the Interior, Bureau of Mines, 1983. Capacity data (1981) -- American Metal Market, 1981.

[a] Includes only old scrap.

[b] Historical data is not available on industry capacity. Industry sources suggest capacity levels remained relatively constant over the 1978-1982 period.

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the secondary aluminum industry are described in the Development Document. The treatment options considered for this industry are as follows:

- Option B - This option includes recycle of casting contact cooling water using cooling towers (where required), equalization, activated carbon adsorption (where required), ammonia steam stripping (where required), oil skimming, equalization, chemical precipitation, and gravity settling.
- Option C - This option includes Option B plus multimedia filtration of the final effluent.

2. Costs for Existing Plants

Compliance cost estimates for two treatment options are developed for each of the plants and are presented in Table VII-5.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

The plant-specific compliance costs for each treatment option are compared to anticipated revenues. Total annual compliance costs include operating and maintenance costs, depreciation, and annualized capital costs. The estimated revenue is based on a metal selling price of $1,567.08 per ton and a capacity utilization rate of 63 percent. The threshold value for the screen is 1 percent. If compliance costs for a plant represent less than 1 percent of revenues, the plant is not expected to incur significant costs and is not analyzed for potential closure.

The results of the screening assessment show that the compliance costs are less than 1 percent of anticipated revenue even under the more costly alternative for all direct dischargers. One indirect discharger, however, does not pass the screen, and is analyzed further using a detailed cash-flow analysis.

2. Plant Closure Analysis

The potential closure candidate is further analyzed with the liquidity and the NPV tests. The results of the liquidity test for this plant show that annual net cash flows are positive under both Options B and C, indicating that the plant will not have any cash problems in the short run (five years) due to this regulation. Therefore, the liquidity test does not project closure for this plant.

TABLE VII-5

SECONDARY ALUMINUM -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs		Total Annual Costs	
	Option B	Option C	Option B	Option C
Direct Dischargers				
312	35,062	37,675	23,113	24,861
320	224,812	227,975	99,756	101,882
327	39,462	59,125	20,266	23,318
333	145,337	175,450	59,853	68,314
342	105,325	107,800	18,848	19,594
505	120,175	140,937	48,314	53,707
626	76,312	80,850	26,813	29,390
628	209,275	213,262	44,531	46,730
4101	88,931	89,379	14,095	14,233
Subtotal	1,044,691	1,132,453	355,587	382,028
Indirect Dischargers				
14	53,900	57,062	21,680	23,410
18	198,275	202,812	45,666	48,112
37	229,762	252,037	94,179	100,234
48	182,600	188,100	56,569	59,496
309	60,500	63,387	21,790	23,364
310	0	0	660	660
319	198,000	207,487	55,750	60,678
326	291,500	313,912	155,487	161,619
332	232,512	255,750	117,540	124,009
335	29,562	32,037	17,869	19,209
340	121,550	127,600	24,567	26,222
427	203,500	224,950	78,804	84,522
624	29,562	32,037	18,734	20,140
4104	173,525	197,175	74,148	80,785
4501	105,462	109,175	18,028	20,731
Subtotal	2,110,210	2,263,521	801,471	853,191
TOTAL	3,154,901	3,395,974	1,157,058	1,235,219

SOURCE: U.S. Environmental Protection Agency.

Detail may not add to totals due to rounding.

For the NPV test, if U/L, operating income as a percentage of the liquidation value of a plant, as defined in Chapter II, is greater than the real cost of capital for the industry (4.04 percent), the plant will continue in operation. The results of the NPV test show that U/L, under both options, is greater than the real cost of capital. Thus, no plant closures have been identified in the secondary aluminum industry as a result of this regulation.

3. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

The financial impact of the regulatory options on the secondary aluminum industry is evaluated in terms of the increase in cost of production. An estimate of the cost of production is made as the difference between revenues and operating income. The following table shows the estimated increase in cost of production under each treatment option.

	Increase in Cost of Production	
	Option B	Option C
Direct Dischargers	0.09	0.10
Indirect Dischargers	0.20	0.22

As shown in the table, the increase in cost of production is very low and is not significant enough to result in any structural changes in the domestic secondary aluminum industry.

b. Price Change

Total annual compliance cost as a percentage of total revenue is used to assess the maximum increase in price under the assumption of full pass-through of incremental costs. Although some plants have very low compliance costs associated with these regulations, an average of compliance costs for all plants gives a reasonable estimate of the increase in price required to cover those costs. The following table shows the estimate of these price increases. It should be noted that in performing the screening and closure analyses, zero cost pass-through is assumed.

	Price Change	
	Option B	Option C
Direct Dischargers Indirect Dischargers	0.09 0.20	0.09 0.21

Thus, if the industry were able to pass all incremental costs on to the consumers, prices would have to increase by no more than 0.21 percent, which is considered an insignificant amount.

c. Change in Return on Investment

The pre-compliance real return on investment for secondary aluminum industry is calculated as 4.04 percent. As a result of the additional compliance costs, overall profitability of the industry is reduced. The following table presents estimates of this decrease in profitability.

	Change in Return on Investment	
	Option B	Option C
Direct Dischargers Indirect Dischargers	-3.57 -7.96	-3.83 -8.48

The expected reduction to return on investment is no more than 8.48 percent for either option. This is not expected to adversely impact the profitability of secondary aluminum plants.

d. Capital Impacts

The additional capital investment required to purchase the necessary treatment equipment is compared to the average annual expenditures of secondary aluminum plants to measure the effect of such costs on a plant's financial resources. The analysis is presented in the following table.

	Investment Cost as a % of Capital Expenditure	
	Option B	Option C
Direct Dischargers Indirect Dischargers	7.86 15.95	8.52 17.11

The table shows that incremental investment ranges from 7.86 to 17.11 percent of annual capital expenditures. Although higher for indirect dischargers than for direct dischargers, the investment costs are not a significant portion of annual expenditures and should not adversely affect a plant's ability to fund other capital improvements.

e. Employment Impacts

Employment effects are examined in the context of plant closures. Since no plant closures have been identified in the secondary aluminum industry, it is estimated that there will not be any adverse impact on employment. Small production decreases, if any, caused by the higher cost of production will not result in capacity shutdowns. Thus, with minimal changes in prices or production, employment will remain essentially unchanged by this regulation.

f. Foreign Trade Impacts

The economic impact of the compliance costs on the balance of trade is evaluated in relation to domestic prices and production. Domestic prices are estimated to remain at levels competitive with international prices (mainly LME prices). Similarly, it is assumed that domestic production will not be hampered by these regulatory costs. With small changes in price and production, there will not be any general increase in imports. The balance of trade is not expected to be affected by these regulations.

CHAPTER VIII

SECONDARY COPPER

VIII. SECONDARY COPPER

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States secondary copper industry of the cost of alternative pollution control technologies.

The technology used to produce copper from scrap is briefly discussed in Section B. Section C presents the industry structure. Secondary copper demand and consumption is described in Section D, and current trends in the industry are discussed in Section E. Section F presents estimates of prices and capacity utilization. Section G contains effluent control guidelines and costs; Section H presents the results of the analysis.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise noted.

B. TECHNOLOGY

The secondary copper industry converts copper scrap into two types of intermediate products: refined unalloyed copper, and brass and bronze alloys. The industry uses many of the same processes as primary copper facilities, such as smelting, fire-refining, and electrorefining, as well as other processes unique to the secondary industry.

1. Refined Unalloyed Copper

Refined unalloyed copper produced by the secondary industry competes directly with primary refined copper. Any copper-bearing scrap can be utilized. The process employed depends on the grade of scrap being used, and many variations are possible.

Low-grade copper and brass scraps, refinery slags, drosses, and skimmings are charged into a blast furnace or cupola furnace along with coke, fluxes, and sulfur. In the furnace, metallic and non-metallic copper materials are chemically reduced to 80-90 percent pure copper metal. The non-copper materials form a slag layer.

Copper products (i.e., blister copper) smelted from low-grade scrap, slags, drosses, and sludges are brought together with other impure copper products for fire refining. The impurities are removed by melting the scrap in an oxidizing atmosphere. Electrolytic refining may be necessary if silver and gold remain in the copper in substantial amounts after fire refining.

2. Brass and Bronze Alloys

Charge materials used in making brass or bronze ingots consist of batches or lots of scrap selected to produce a melt of the desired composition with a minimum of flux and as little dilution of metal constituents as possible. Scrap is charged at regular intervals until the furnace is filled to capacity. Melting is more efficient if light scrap is densified by baking or briquetting. Oxidation and volatilization losses from copper-based alloys are usually kept to a minimum by rapid melting in a slightly oxidizing atmosphere with a fairly fluid slag cover.

The stationary reverberatory furnace is the most practical one for producing very large tonnages of standard alloys from scrap.

C. INDUSTRY STRUCTURE

1. Overview

Copper is one of the most extensively recycled of the common metals. Recycled metal constitutes a substantial part of domestic copper supply. The unalloyed refined copper produced by the secondaries competes directly with the unalloyed metal produced by the primaries. Unalloyed copper can be in the form of blister copper, fire-refined copper, cathodes, wire bar, continuous cast, or finished product, depending upon both the production scheme and customer specifications. Several precious metals are also recovered as a result of electrorefining to produce cathode copper. Cathode copper has become the single most important commercial form of refined copper. Alloyed copper (brass and bronze ingot) from scrap is generally produced by small and individually owned firms. The brass and bronze producers operate in a market which is linked to the primary copper market (i.e., scrap and ingot are both priced on copper content and copper price), but direct competition between the two rarely occurs.

2. Secondary Smelters and Refineries

Copper-bearing scrap is the single most important scrap used to recover copper. As shown in Table VIII-1, copper recovery from scrap other than copper-base is generally a small portion of total recovery. Between 1962-1982, copper-base scrap contributed 97-99 percent to total copper recovery. New scrap is generally excluded from supply-demand balances since it does not, in general, represent an inflow of copper to the industry. New scrap, or manufacturing scrap, is generated during the fabrication of copper products. The larger fabricators, such as the major brass mills, remelt their own scrap; smaller fabricators sell the scrap they generate to scrap dealers who sell it to brass mills, refineries, and other scrap consumers. About one-quarter of the copper in new scrap is recovered as refined copper; the remainder is recovered in alloyed form, mostly by brass mills. Old scrap consists of worn-out, discarded, or obsolete copper-containing end products. In 1981, total scrap (new plus old) contributed 45 percent of copper input to the manufacturing process. Old scrap alone accounted for 19 percent of the copper in the input.

U.S. imports and exports of copper-base scrap are presented in Table VIII-2. While there has been little change in imports since 1976,

TABLE VIII-1

DOMESTIC COPPER RECOVERY FROM SCRAP

(copper content, thousands of short tons)

Year	Recovery from Copper-Base Scrap[a]	Recovery from Scrap Other than Copper Base[a]	Total Recovery
1962	480.4	5.2	485.6
1966	627.1	6.8	633.9
1969	686.0	[illegible]	692.1
1975	440.1	[illegible]	450.8
1978	563.3	16.9	580.2
1979	603.3	18.0	621.3
1980	604.5	16.4	620.9
1981	585.4	16.8	602.2
1982[b]	520.7	14.1	534.8

SOURCE: Annual Data 1983: Copper Supply and Consumption, Copper Development Association, Inc.

[a] Includes production from old scrap only.

[b] Preliminary.

TABLE VIII-2

U.S. IMPORTS AND EXPORTS OF COPPER-BASE SCRAP

(copper content, thousands of short tons)

Year	Imports	Exports	Net Exports (Imports)
1962	7.2	38.3	31.1
1964	5.2	93.9	88.7
1966	31.7	49.8	18.1
1970	3.8	82.8	79.0
1972	18.8	58.0	39.2
1976	29.4	83.5	54.1
1978	28.8	124.7	95.9
1979	32.0	132.7	100.7
1980	32.5	153.3	120.8
1981	38.8	118.8	80.0
1982[a]	38.8	120.6	81.8

SOURCE: Annual Data 1983: Copper Supply and Consumption, Copper Development Association, Inc.

[a] Preliminary.

exports rose substantially between 1976-1980. Exports in 1980 were approximately 84 percent higher than 1976 levels. The U.S. has historically been a net exporter of copper-based scrap. However, with declining demand in 1981 and 1982, exports fell by about 20 percent.

3. Description of Plants

Several of the secondary copper refiners are integrated forward into captive fabricating facilities using copper as a raw material and turning out saleable finished products such as electrical wire, valves, fittings, and copper tubings. Aurax and Cerro-Marman Corporation have historically been the two most important secondary copper refiners. While Aurax sells refined copper, Cerro-Marman and a number of other corporations, e.g., Chemetco, Southwire, and Reading, consume most of their refined copper output in their own captive fabricating facilities. The producers of unalloyed copper are generally not diversified; however, many of these firms produce a number of precious metals as a by-product or co-product. These precious metals are derived from such sources as printed circuit boards and electrical contacts contained in the scrap feed material.

The brass and bronze producers manufacture a wide variety of copper-based alloys. Almost all of these firms have established a moderate level of diversification. In many cases, the plants are also processors of secondary aluminum and frequently secondary lead and zinc-based materials. Often they are combined with steelyard operations. For the most part, the secondary brass and bronze ingot-making segment of the industry is non-integrated. None of the smallest smelters is integrated to the point of producing a finished or semi-finished product. Basically, each produces alloy ingots.

D. SECONDARY COPPER DEMAND

Copper-containing scrap, accumulated by manufacturing plants and scrap dealers, flows to brass mills, ingot-makers, foundries, powder plants, and other industries. About 70 percent of domestic copper is used as unalloyed copper, while nearly 30 percent is used in brasses and only 2 percent is used in bronzes. Cathode copper has become the single most important commercial form of refined copper, accounting for nearly three-fourths of the refined copper consumed annually; it is used directly by many wire-rod mills, without being cast into wire bars. A considerable quantity of refined copper is melted and cast into various refinery shapes for consumer use.

Domestic consumption of copper scrap by end-use is presented in Table VIII-3. Between 1962-1982, brass mills accounted for an average of 54 percent of total scrap consumption, followed by ingot-makers (24 percent), and foundries (11 percent). Copper scrap consumption by brass mills, ingot-makers, and foundries peaked in 1979. By 1982, consumption by most markets had fallen approximately 25 percent below 1979 levels. The major brass mill products are sheet, strip and plate, rod, bar and mechanical wire, plumbing tube and pipe, and commercial tube and pipe. Foundries accounted for 113,000 short tons of scrap in 1979. Powder

TABLE VIII-3

DOMESTIC CONSUMPTION OF COPPER SCRAP

(copper content, thousands of short tons)

	1962	1966	1972	1978	1979	1980	1981	1982[a]
Consumption of Copper Scrap by:[b]								
Brass Mills	345.6	485.7	578.4	541.7	608.0	532.3	559.3	447.5
Ingot Makers	233.3	293.0	250.5	205.5	238.2	214.0	213.0	173.2
Foundries	121.4	144.0	121.7	105.2	113.0	87.0	84.7	72.1
Powder Plants	12.3	15.3	16.0	18.5	18.1	12.8	12.9	10.1
Other Industries[c]	40.4	52.0	76.4	100.5	107.9	102.1	104.2	66.1
Total Copper Consumed	753.0	490.0	1,043.0	971.4	1,085.2	948.2	974.1	769.0

SOURCE: Annual Data 1983: Copper Supply and Consumption,
Copper Development Association, Inc.

[a] Preliminary.

[b] Includes both old and new scrap.

[c] Chemical, steel, aluminum, and other industries.

plants account for about 1-2 percent of total copper scrap consumption. Consumption by chemical, steel, and other industries increased substantially between 1962-1982; by 1979, consumption had more than doubled from the 1962 level of 40,400 short tons. However, 1982 consumption was approximately 39 percent below the 1979 levels.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

The price of scrap, which represents 75 percent of the cost of producing secondary copper, is a fundamental determinant of the financial performance of this industry. The price of copper scrap is determined in the scrap market. The market is competitive with many participants on both the demand and supply sides. International trade in scrap also significantly affects supply conditions, and therefore has an influence on domestic scrap price levels.

The prices for the various scrap types are separated by a generally constant difference which reflects the quality of scrap and the ease of processing it into ingot. Published data on scrap prices are indicative, yet do not pinpoint the level at which transactions actually occur. The American Metal Market publishes a price series for various grades of copper scrap, as well as for various standard grades of brass and bronze ingot. The ingot prices, which represent list prices, closely correlate with the price of scrap. Because they compete in the same markets, primary and secondary copper producers sell at the same prices.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the secondary production of copper will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average copper price and average capacity utilization rate for the 1978-1982 period. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the secondary copper industry.

The copper price for the analysis is $1,972.40 (see Table VIII-4). The capacity utilization rate is 87 percent (see Table VIII-5). For both prices and utilization rates, the values used in the analysis show improvement over 1982. This assessment is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM) which shows an overall improvement in the secondary copper industry. Specifically, the BOM projects secondary copper demand to increase at an average annual rate of 2 percent from 1981 to 2000. (Mineral Commodity Profiles, Bureau of Mines, 1983).

TABLE VIII-4

AVERAGE ANNUAL U.S. PRODUCER COPPER PRICE

Year	Cents per Pound		1982 Dollars per Ton
	Actual	1982 Dollars	
1978	66.5	91.6	1,832.00
1979	93.3	1118.3	2,366.00
1980	102.4	118.7	2,374.00
1981	85.1	90.2	1,804.00
1982	74.3	74.3	1,486.00
			Average = 1,972.40

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE VIII-5

SECONDARY COPPER PRODUCTION AND CAPACITY[a]

(thousands of metric tons)

Year	Production	Capacity	Capacity Utilization
1978	242	350	69%
1979	346	350	99%
1980	300	300	100%
1981	274	300	91%
1982	237	300	79%
		Average =	87%

SOURCE: Minerals Yearbook,
U.S. Department of the Interior,
Bureau of Mines, 1979-1982.

[a] Includes production and capacity data for secondary plants only.

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the secondary copper industry are described in the Development Document. The treatment option analyzed for this industry is as follows:

- Option G - This option consists of equalization, lime and settle of all process water with oil skimming where necessary, vacuum filtration and contract hauling of sludge. This option also includes flow reduction of casting water via a cooling tower or holding tank and 100 percent recycle of all treated water to reuse in the plant.

2. Costs for Existing Plants

Six secondary copper plants are expected to incur costs to comply with this regulation. They include five smelters and one integrated refiner. Table VIII-6 presents the total investment and annual costs for each treatment level. All six secondary copper plants are indirect dischargers.

H. ECONOMIC IMPACT RESULTS

1. Screening Analysis

The plant-specific compliance costs for each treatment option are compared to anticipated revenues. Plants with total annual compliance costs in excess of 1 percent of annual plant revenues were analyzed according to the closure analysis described in Chapter II. Plants with total annual compliance costs less than the threshold value of 1 percent are not expected to face difficulty in incurring the compliance costs and were not analyzed further. The results of the screening assessment show that no plant has total annual compliance costs in excess of 1 percent of annual plant revenues. Since no secondary copper plants violated the screening analysis, there are no expected plant closures in this industry due to this regulation.

2. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

TABLE VIII-6

SECONDARY COPPER -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs	Total Annual Costs
	Option G	Option G
Indirect Dischargers		
15	95,012	16,025
16	10,099	31,487
17	10,175	21,862
37	9,598	50,187
207	103,948	424,050
9050	10,099	31,487
TOTAL	159,945	654,085

SOURCE: U.S. Environmental Protection Agency.

a. Increase in Cost of Production

The financial impact of the regulatory alternatives on the secondary copper industry has been evaluated in terms of the increase to cost of production. This impact is measured by calculating the ratio of total annual compliance cost to total production cost. This ratio represents the percentage increase in operating costs due to compliance expenditures. Cost of production is assumed to equal revenues minus operating income. The results are presented below.

	Increase in Cost of Production Option G
Indirect Dischargers	0.07

As shown above, the increase in cost of production is not of significant magnitude to cause structural changes in the domestic secondary copper industry.

b. Price Change

The ratio of total annual compliance cost to annual plant revenue is used to assess the maximum increase in price under the assumption of full pass-through of incremental compliance costs. The average for this ratio is presented below. It should be noted that in performing the screening and closure analyses, zero cost pass-through is assumed.

	Price Change Option G
Indirect Dischargers	0.06

Thus, if all incremental costs are passed on to the consumers, prices would rise by only 0.06 percent. This represents a very small impact on the competitiveness of the secondary copper plants subject to this regulation.

c. Change in Return on Investment

Additional compliance costs may adversely affect profitability by reducing profit margins and consuming investment capital. Computed on an industry-wide basis, changes in return on investment are presented below.

	Change in Return on Investment Option G
Indirect Dischargers	-2.73

As a result of additional compliance costs, return on investment for the secondary copper plants can be expected to decline only 2.73 percent. This is not a significant impact on plant profitability.

d. Capital Impacts

On an industry-wide basis, investment compliance costs represent 8.04 percent of average annual industry capital expenditures. These results are presented below.

	Investment Costs as a % of Capital Expenditures Option G
Indirect Dischargers	8.04

Costs of this magnitude will not have an adverse impact on funds available for other capital improvements.

e. Employment Impacts

Because there are no projected closures, no major adverse employment impacts are anticipated. Small production decreases, if any, caused by the higher cost of production will not result in capacity shutdowns. Thus, employment will remain essentially unaffected by this regulation.

f. Foreign Trade Impacts

Despite the highly competitive nature of the world market for copper products, very small increases in production costs, discussed above, are not expected to materially reduce competitiveness or affect the balance of trade.

CHAPTER IX

SECONDARY LEAD

IX. SECONDARY LEAD

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States secondary lead industry of the cost of alternative pollution control technologies.

The technology used to produce lead from scrap is briefly discussed in Section B. Section C describes the structure of the industry. Section D discusses lead demand and end-use markets, and Section E covers current industry trends. Section F discusses price and capacity utilization estimates. Section G presents the cost estimates for the alternative control technologies. The results of the economic impact analysis are discussed in Section H.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise indicated.

B. TECHNOLOGY

Secondary lead is lead recovered from new scrap (refinery drosses and residues), home scrap or runaround scrap (which is generally in the form of lead metal), and old scrap consisting of product wastes (battery plates and oxides, cable covering, pipe, and sheet). Some secondary lead materials are re-used after remelting without refining, but an increasing proportion is processed in refineries to meet customer specifications. Normally, three grades of lead are produced: refined or soft lead, antimonial or hard lead, and remelt lead.

Soft lead is generally produced from new scrap and/or runaround scrap. New scrap, composed of drosses and residues, normally contains various impurities, and must therefore be refined for re-use.

Battery scrap used to produce antimonial lead accounts for the largest category of lead scrap recycled. Whole battery scrap is decased to separate the metallic components from the non-metallic waste. The Ginatta process, developed by an Italian manufacturing company, involves cutting the bottoms off spent batteries and immersing them directly in an electrolytic solution preparatory to metal recovery.

Smelting is carried out by feeding the prepared scrap material into a furnace. If only hard lead (or alloy) is to be produced, all of the scrap can be charged to the blast furnace. However, producers generally use reverb/blast furnace combinations to meet customer specifications.

The lead scrap consisting of antimonial lead battery plates, battery paste containing lead oxide, and other scrap with lead or lead alloy is melted under mildly reducing conditions in the reverb. Upon melting, two layers are formed -- a lead layer containing about half of the incoming lead and less than 1 percent antimony and other impurities, and a slag layer containing lead oxide (65-90 percent), antimony oxide (5-9 percent), and other impurities.

The reverb slag is cast, cooled, and charged to the blast furnace along with coke, limestone, scrap iron, sand, re-run slag, and some lead scrap or residues. The lead produced in the blast furnace, because of the high antimony reverb slag, typically is antimonial lead containing 2-7 percent antimony.

The lead from the reverb and blast furnaces is refined in kettles by the addition of various fluxes such as sodium hydroxide, sulfur, and sodium nitrate, to adjust the final composition to meet the desired product specifications.

C. INDUSTRY STRUCTURE

1. Overview

The United States is the leading producer of both primary and secondary lead. In secondary refined lead production, the U.S.S.R. ranked second, followed by the United Kingdom, the Federal Republic of Germany, and Italy. Nine countries that refined over 50,000 tons each in 1981 constituted 77 percent of the world's secondary refined metal output. The chief source of secondary lead is automobile storage batteries that have been scrapped after use. In the United States and other industrialized countries, about 90 percent of the lead used in the manufacture of storage batteries is recycled.

Production from secondary lead smelters, as shown in Table IX-1, increased by 36 percent between 1968-1979, peaking at 742,000 short tons in 1979. Secondary lead production has since decreased owing to inadequate scrap availability and low lead prices. Production in 1982 was 16 percent lower than that of 1979. Nonetheless, secondary lead supplied about 52 percent of the total domestic demand in 1982, a fall of only 1.5 percent from the 1979 level. Gradual structural and technological changes in the industry are expected to result in greater recycling by the secondary lead industry.

As shown in Table IX-2, domestic exports of lead scrap increased sharply between 1971-1980. Some of this increase was due to high domestic costs of processing scrap. In the 1960s, exports averaged 3,600 tons per year. In the 1970s, the average jumped to 60,000 tons per year, reaching more than 131,000 short tons of lead scrap export in both 1979 and 1980. However, depressed foreign markets resulting from the worldwide economic recession in 1981 and 1982 have effected a substantial decrease in U.S. exports of lead scrap. Exports fell by 57 percent in the 1979-1982 period.

TABLE IX-1

U.S. PRIMARY AND SECONDARY LEAD PRODUCTION

(thousands of short tons)

Year	Total Production	Primary Refined	Secondary[a]	Secondary as a % of Total
1968	1,018	467	551	54.0
1971	1,247	650	597	47.8
1974	1,372	673	699	50.9
1976	1,276	653	623	48.8
1978	1,339	623	716	53.4
1979	1,377	635	742	53.9
1980	1,245	604	641	51.5
1981	1,183	546	637	53.8
1982	1,186	565	621	52.4

SOURCE: Non-Ferrous Metal Data -- 1982, American Bureau of Metal Statistics.

[a] Does not include production from new scrap.

TABLE IX-2

U.S. EXPORTS OF LEAD SCRAP

(short tons)

Year	Exports
1971	17,091
1974	59,366
1978	108,723
1979	131,998
1980	131,820
1981	65,498
1982	57,047

SOURCE: Non-Ferrous Metal Data -- 1982,
American Bureau of Metal Statistics.

2. Secondary Smelters

The secondary lead industry is split into four segments:

1) large integrated battery producers;

2) operators of large or multiplant secondary smelters;

3) small single-plant secondary smelting companies, including small integrated battery producers; and

4) recycling/remelting firms.

The first three segments primarily smelt battery plates and oxides, while the recycling/remelting segment reclaims lead from a variety of obsolete and recycled materials.

a. Integrated Battery Producers

The largest integrated operator is Gould Incorporated, with two operating plants and about 120,000 tons of lead smelting capacity. Gould's capacity increased following the opening of a new 80,000-ton-per-year secondary lead smelter in Los Angeles.

General Battery Inc. and Chloride Inc. (a British company) each have more than one secondary smelter and each total over 40,000 tons in annual lead capacity. Exide (Refined Metals) recently closed two smelters at Beech Grove, Illinois, and Jacksonville, Florida, and now operates only one facility, in Memphis, Tennessee.

b. Large Secondary Smelting Companies

In addition to the large integrated battery manufacturers, a number of firms produce secondary lead at large smelters. The largest of these firms is RSR, with five plants and a total capacity approaching 200,000 tons. Other large firms with capacity at several plants include Schuylkill Metals, Taracorp, and Bergsoe. In addition, several other single-plant firms have significant capacity, including Sanders Lead (Troy, Alabama), Tonolli (Nesquehoning, Pennsylvania), and ILCO (Leeds, Alabama).

c. Small Independents and Integrated Battery Producers

There are approximately 13 small independent secondary smelter operators, four of which are integrated battery producers. These firms operate smelters producing from 1,000 to 20,000 tons of lead per year. These firms range from old established firms, such as Viener Metals, to the new secondary smelter in Tennessee opened in 1980 by Ross Metals. Also included in this group is National Smelting and Refining, a subsidiary of Standard Metals Corporation, which operates the Sunneyside lead-zinc mine in Colorado. These two groups represent almost 20 percent of total secondary smelting capacity.

d. Recyclers/Remelters

Small tonnages of lead are reclaimed in remelting operations. The main sources of lead metal are cable scrap, type metal and alloys, lead-bearing slags and drosses, and scrap resulting from battery production processes. A large plant producing 10,000 batteries per day would remelt about 1,000 to 1,500 tons of lead waste per year on an intermittent basis -- that is, whenever enough waste is accumulated to make remelting worthwhile.

Some of the lead remelters included in this category are Delco-Remy, Nassau Smelting (a subsidiary of Western Electric which reclaims lead cable), Asarco-Federated Division, Roth Brothers, Canton Metals, River Smelting, Inland Metals, and Detroit Smelting.

Actual secondary production is constrained by lead scrap availability. These producers probably produce about 80,000 tons in reverb and rotary-type furnaces on an intermittent basis.

D. LEAD DEMAND

Demand for lead is independent of the production source, whether primary or secondary. Batteries, chemicals, paints, and ammunition are the major end-use markets for lead. For a description of these markets and demand patterns for the lead industry as a whole, see Chapter V, Section D.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

Most of the firms engaged in secondary lead smelting and battery manufacture are privately held. However, irrespective of their ownership status, practically all secondary manufacturers follow the price set by the primaries. Some of them have installed equipment to remove antimony from recycled antimonial lead to achieve the higher purity soft lead. This move has led to direct competition between the primaries and the secondaries.

The 1980-1982 decline in lead prices has created a difficult market environment for most secondary producers. Low lead prices and non-availability of scrap resulted in a capacity shutdown of about 320,000 tons between 1979-1981. NL Industries, formerly the largest producer of secondary lead with nine secondary smelter facilities, divested itself of its metal recovery operations in 1979 by selling all but two of its recycling plants.

Three large battery producers, each with more than 40,000 tons of smelter capacity, are now highly integrated with two or more smelters. In addition, four other non-integrated secondary lead producers have large or multiple plants with more than 60,000 tons of smelting capacity. While total secondary capacity totalled over 1.0 million tons in 1982, available lead scrap was limited to about 750,000-850,000 short tons, of which foreign buyers acquired 14-15 percent. Low ocean transport costs enabled foreign buyers to bid competitively for U.S. lead scrap in some coastal markets, e.g., San Francisco and Boston.

Lead is an internationally traded commodity; its price is determined in the world marketplace. Both primary and secondary producers have very little influence on the determination of this price. The domestic market price varies from the London Metal Exchange price only to the extent of the import duty and transportation charges.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the secondary production of lead will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the 1978-1982 period. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the secondary lead industry.

The lead price for the analysis is $906.32 per ton (see Table IX-3). The capacity utilization rate is 67 percent (see Table IX-4). For both prices and utilization rates, the values used in the analysis show improvement over 1982. This assessment is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM), which shows an overall improvement in the secondary lead industry. Specifically, the BOM projects secondary lead demand to increase at an average annual rate of 2 percent from 1981 to 2000 (Mineral Commodity Profiles, Bureau of Mines, 1983).

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the secondary lead industry are described in the Development Document. The treatment options considered for this industry are as follows:

- Option A - This option includes equalization, chemical precipitation, and sedimentation, with oil skimming where necessary.
- Option B - This option includes Option A plus flow reduction of casting water via a holding tank or cooling tower.
- Option C - This option includes Option B plus multimedia filtration of the final effluent.

2. Costs for Existing Plants

The costs for three treatment options are analyzed. The compliance cost estimates for each of the plants are presented in Table IX-5.

In addition to effluent control regulations, the secondary lead smelting industry will also be subject to lead exposure limitations, which have been promulgated by the U.S. Occupational Safety and Health

TABLE IX-3

AVERAGE ANNUAL U.S. PRODUCER PRICE OF LEAD

Year	Cents per Pound		1982 Dollars per Ton
	Actual	1982 Dollars	
1978	33.7	46.43	928.60
1979	52.7	66.79	1,335.80
1980	42.4	49.17	983.40
1981	36.5	38.69	773.80
1982	25.5	25.50	510.00
			Average price = $906.32

SOURCE: *Mineral Commodity Profiles*, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE IX-4

SECONDARY LEAD PRODUCTION AND CAPACITY

(thousands of short tons)

Year	Production	Capacity[a]	Capacity Utilization
1978	848	1,138	75%
1979	883	1,138	78%
1980	745	1,138	65%
1981	707	1,138	62%
1982	612	1,138	54%
			Average = 67%

SOURCE: Production Data -- Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983. Capacity Data (1982) -- Economic and Environmental Analysis of the Current OSHA Lead Standard, U.S. Department of Labor, Occupational Safety and Health Administration, 1982.

[a] Historical data are not available on industry capacity. Industry sources suggest capacity levels remained relatively constant over the 1978-1982 period.

TABLE IX-5

SECONDARY LEAD COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs			Total Annual Costs		
	Option A	Option B	Option C	Option A	Option B	Option C
Direct Dischargers						
225	106,700	106,700	126,225	47,391	47,391	52,148
234	144,375	144,375	179,850	113,390	113,390	123,907
271	198,962	198,962	224,675	57,121	57,121	64,535
391	152,212	152,212	182,462	78,063	78,063	86,602
428	414,562	414,562	441,650	102,742	102,742	110,672
652	305,800	305,800	331,512	82,943	82,943	90,356
655	110,687	110,687	142,450	73,118	73,118	82,252
6605	197,725	197,725	232,512	129,161	129,161	139,486
Subtotal	1,631,023	1,631,023	1,861,336	683,930	683,930	749,958
Indirect Dischargers						
222	211,062	211,062	216,287	56,106	56,106	58,942
223	282,150	282,150	308,825	89,847	89,847	97,608
239	73,700	73,700	101,062	55,611	55,611	63,632
244	277,475	298,375	319,687	71,922	73,697	80,327
248	172,975	172,975	203,637	85,132	85,132	93,839
249	263,725	263,725	284,487	70,749	70,749	76,142
254	106,150	106,150	128,837	20,003	20,003	26,291
263	144,100	144,100	168,575	84,255	84,255	91,228
264	175,037	175,037	205,562	89,546	89,546	98,242
265	94,875	94,875	116,050	69,150	69,150	74,711
266	92,125	92,125	116,187	60,413	60,413	67,218
272	74,250	74,250	84,287	31,020	31,020	36,392
273	349,525	349,525	373,037	80,777	80,777	87,403
392	109,725	109,725	133,100	59,986	59,986	66,533
427	71,775	74,800	77,825	153,090	16,251	17,706
6601	171,187	171,187	218,762	101,814	101,814	116,499
6602	457,050	457,050	533,637	108,507	108,507	131,819
6603	71,500	71,500	80,025	32,682	32,682	36,930
6604	124,987	124,987	146,437	62,580	62,580	68,298
6606	11,990	11,990	15,565	3,088	3,088	4,063
6608	57,475	57,475	82,362	10,831	10,831	14,013
6611	0	0	9,625	0	0	4,478
6614	0	0	2,750	0	0	1,562
6615	0	0	3,025	0	0	1,124
9001	301,537	301,537	327,250	85,512	85,512	92,926
Subtotal	3,694,375	3,718,300	4,256,883	1,344,922	1,347,558	1,507,926
	5,325,398	5,349,323	6,118,219	2,028,852	2,031,488	2,257,884

SOURCE: U.S. Environmental Protection Agency.

Administration (OSHA). The lead standards are expected to result in compliance costs at approximately the same time as the effluent control regulations. In order to properly assess the effect of the effluent control costs, the lead standard costs and impacts were incorporated into the baseline of the following analysis (discussed in the Response to Comments, included in the rulemaking record). Thus, the following analysis is incremental over the impacts associated with the OSHA regulations, and the conclusions appropriately reflect the costs of effluent controls.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

The plant-specific compliance costs are used to assess the probability of plant closures using the methodology presented in Chapter II. Individual plants are screened by comparing total annual compliance costs to annual revenues. The threshold value for this screen is 1 percent. If the compliance costs for a plant represent less than 1 percent of revenue, the plant is assumed not to face difficulties with the cost of pollution control requirements.

The results of the screening assessment show that four indirect dischargers and one direct discharger have total annual compliance costs greater than 1 percent of their annual revenues under all three treatment levels. One direct discharger exceeds the threshold for Option C only. These plants have been analyzed further using the liquidity test and the net present value (NPV) test.

2. Plant Closure Analysis

The plants failing the screen were further analyzed using the liquidity test and the net present value test. The liquidity test assesses the short-term viability of the firm. If the pollution control expenditures cause negative cash flow over a short period (five years), the plant may not have adequate cash reserves to meet short-term contingencies. The results for these six secondary lead plants indicate that all cash flows are positive, so that all plants are viable in the short run.

For the NPV test, the ratio of income to liquidation value, as defined in Chapter II, is greater than the real cost of capital (4.04 percent) for all six plants under all options. The net present value test evaluates the long-term economic viability of a firm. Based on the results of the liquidity and NPV tests, it is estimated that plants in the secondary lead industry will remain profitable and no closures will result from this regulation.

3. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase In Cost of Production

The effect of regulatory compliance on the financial performance of the secondary lead industry is evaluated in terms of the increase in cost of production. An estimate of the increase in cost of production is made using the incremental compliance costs. The following table presents the estimated increases in cost of production under all three alternatives.

	Increase in Cost of Production		
	Option A	Option B	Option C
Direct Dischargers	0.40	0.40	0.44
Indirect Dischargers	0.31	0.31	0.35

As shown in the table, the increase in cost of production is less than 0.5 percent, even under the most costly option. These low results suggest that there will not be any significant increases in the production costs of the secondary lead industry.

b. Price Change

Production costs will increase as a result of incremental pollution control costs. The table below shows the maximum price increase under each option, if producers are able to pass on compliance costs to consumers in the form of increased prices. The assumption of complete cost pass-through is not used in the closure or screening analyses.

	Price Change		
	Option A	Option B	Option C
Direct Dischargers	0.39	0.39	0.43
Indirect Dischargers	0.30	0.30	0.34

The maximum price increase is only 0.43 percent; hence, the price increase, if implemented, would not have a significant impact on the industry.

c. Change in Return on Investment

Additional compliance costs may adversely affect profitability by reducing profit margins and consuming investment capital. The table below summarizes the decrease in profitability.

	Change in Return on Investment		
	Option A	Option B	Option C
Direct Dischargers	-15.38	-15.38	-16.90
Indirect Dischargers	-12.16	-12.19	-13.64

The decrease in profitability represented by the above results is not expected to cause a significant impact on plant profitability.

d. Capital Impacts

The estimated pollution control investment costs for each of the secondary lead plants is compared to the annual capital expenditures of the industry. The table below summarizes the effect of new investment costs.

	Investment Cost as a % of Capital Expenditures		
	Option A	Option B	Option C
Direct Dischargers	28.34	28.34	32.34
Indirect Dischargers	24.42	25.59	29.29

This table shows that incremental capital costs are between 24-32 percent under all three options. Costs of this magnitude should not have an adverse impact on the availability of funds for other capital projects.

e. Employment Impacts

Employment impacts have been evaluated relative to plant closures and production change. For minor changes in production levels, no significant change in employment is anticipated. As no plant closures were identified in the secondary lead industry, no major production changes have been identified. The compliance costs are thus estimated to have no impact on employment.

f. Foreign Trade Impacts

The economic impact of the compliance costs on the balance of trade is studied in relation to changes in domestic price and production. As no significant changes in price or production have been estimated, the balance of trade will not be specifically affected as a result of the additional pollution control costs.

CHAPTER X

SECONDARY SILVER

X. SECONDARY SILVER

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States secondary silver industry of the cost of alternative pollution control technologies.

The technology used in silver production is discussed in Section B. The structure of the domestic industry, i.e., the size, location and ownership of the plants, is presented in Section C. Section D discusses silver demand characteristics and end-use markets, and Section E describes current capacity utilization and price trends. Section F estimates prices and capacity utilization for the expected time of compliance. Section G presents the cost estimates for the alternative control options. Section H presents the results of the economic impact analysis.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise indicated.

B. TECHNOLOGY

Three major classes of scrap -- low grade, film, and metallic -- are processed for recovery of silver. The low-grade material includes film, circuit board scrap, sweepings, polishing residues, and sludges from pollution control devices at nonferrous smelters. These materials are either chemically treated or more commonly burned to recover the metal values. The resulting ash or chemical concentrate is then melted with metallic scrap from jewelry and tableware manufacturing and upgraded hydrochemically to remove any base metals. If no other precious metals are present, the refined silver is fabricated into usable forms and sold. If gold or other precious metals are to be recovered, the silver is cast into anodes for electrolytic separation. The silver electrolytic cells separate the silver from the other precious metals. The silver is deposited onto a cathode with the gold and other precious metals remaining behind in a cloth-wrapped anode.

Silver from photographic film is usually recovered by chopping followed by acid stripping of the silver from the film. The silver-rich solution is separated by sedimentation, decantation, and filtration. The plastic portion of the film is usually disposed of as solid waste while the solution is treated to precipitate silver. The dried cake undergoes roasting, and the roasted metal is then cast into ingots or Dore plates. The furnace slag is crushed and classified and the silver concentrate is returned as furnace feed while the tailings are landfilled. Alternately, photographic film may be burned with the silver-bearing ash undergoing roasting followed by casting into ingots or plates.

Dore plates are electrolytically refined on site or, occasionally, shipped to others. If electrolytic refining is practiced, the cell slimes may be further processed for gold and platinum recovery.

Silver-rich solutions from photographic film development and manufacturing undergo precipitation and purification as described above. The recovery of silver from photographic wastes is usually done on a toll basis.

High purity metallic waste is melted after separation and reused if the quality is high. Lower quality scrap is melted and cast as silver bullion and sent to an electrolytic refinery.

C. INDUSTRY STRUCTURE

1. Overview

Secondary silver plays an important part in the balancing of supply and demand of silver. As shown in Table X-1, old scrap (used photo film and other products) accounts for approximately 50 percent of total production. Secondary silver production was the highest in 1980 (the year of record high prices). Total silver production reached a high in 1980 as well -- 132.745 million troy ounces. As silver prices rose, coins became a source of silver for other uses. Silver coins accounted for 13.11 percent of total production in 1980. Since 1980, however, falling prices have led to the re-appearance of silver coins.

Silver scrap is purchased based on value of the contained silver, wherein the purchase price is determined after deducting processing costs. Smelting and refining operations are also conducted on a custom or toll basis, where the scrap is processed for the customer without actually taking title for the material. As shown in Table X-2, in 1981, 74 percent of total production came from the refiners' own or purchased materials. The remainder was produced on a toll basis. In 1980, production on a toll basis was 56.38 million troy ounces, or 34 percent of total refined production.

In 1982, total U.S. consumption of silver was about 125.1 million troy ounces. About 22 percent of this came from the secondary silver industry. The photographic industry, accounting for 40 percent of silver consumption, provided substantial portions of old scrap for recycling.

The United States has traditionally been a net importer of refined silver. In 1980, the year of the record high prices and secondary production, exports rose by approximately 250 percent from the 1979 level, to reach 57.205 million troy ounces. However, in spite of such a vast increase in exports, the United States remained a net importer of refined silver (Table X-3). Exports fell dramatically (by about 74 percent) in 1981 from 1980 levels. Imports, as a percent of apparent consumption, averaged 42 percent between 1978-1982. In 1982, imports averaged 97 million troy ounces of silver. The principal sources for imported silver in 1982 were Canada (37 percent), Mexico (24 percent), and the United Kingdom (5 percent).

TABLE X-1

U.S. REFINED SILVER PRODUCTION BY SOURCE

(999 Fine in thousands of troy ounces)

Year	Total Refined Production[a]	From Primary[b]	Percent of Total Production	From Coins	Percent of Total Production	From Old Scrap[c]	Percent of Total Production
1978	113,353.1	54,384.8	47.98	1,147.1	1.01	57,821.2	51.09
1979	123,836.1	57,050.4	46.07	5,226.2	4.22	61,559.5	49.71
1980	132,724.5	40,476.1	30.50	17,399.1	13.11	74,849.3	56.39
1981	102,684.2	44,326.9	43.17	1,541.6	1.50	56,815.7	55.30
1982	84,361.9	44,250.6	52.45	63.6	0.075	40,047.7	47.47

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics.

Detail may not add to total due to rounding.

[a] Total production does not include production from new scrap.

[b] "From Primary" means from ores, concentrates, etc.

[c] "From Old Scrap" means from used items.

TABLE X-2

REFINED SILVER PRODUCTION BY OWNERSHIP OF SOURCE MATERIALS

(999 Fine in thousands of troy ounces)

Year	Total Production[a]	Refiners' Own or Purchased Materials	Percent of Total Production	Toll for Others	Percent of Total Production
1978	137,325.5	105,979.4	77.17	31,346.1	22.83
1979	151,233.2	107,084.6	70.81	44,148.6	29.19
1980	166,326.2	109,944.2	66.10	5,638.2	33.90
1981	130,782.8	97,581.3	74.61	33,201.5	25.39
1982	108,251.8	--[b]	--[b]	--[b]	--[b]

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics.

[a] Total production includes production from new scrap.

[b] Reporting discontinued.

TABLE X-3

U.S. IMPORTS AND EXPORTS OF REFINED SILVER

(Thousands of troy ounces)

Year	Imports	Exports	Net Exports (Imports)
1978	61,359	9,989	(51,370)
1979	78,372	16,331	(62,041)
1980	64,763	57,205	(7,558)
1981	75,920	15,131	(60,789)
1982	96,917	12,875	(84,042)

SOURCE: Non-Ferrous Metals Data -- 1982, American Bureau of Metal Statistics, Inc.

2. Description of Plants

Entry into the secondary silver industry is relatively easy since the refining of high-grade silver scrap is an uncomplicated operation requiring little capital. Two large companies, Handy and Harman, Inc. and Engelhard Minerals and Chemical Corporation, each control a large portion of the secondary market. These companies are vertically integrated from smelting scrap through refining, and downstream into fabrication and production. Both companies also produce other precious metals.

D. SECONDARY SILVER DEMAND

Silver is critical to the production of many manufactured products. It provides high electrical conductivity, resistance to oxidation, and strength at a wide range of temperatures. Silver consumption in many end uses is based upon the superior performance of the metal or one of its compounds. Silver consumption by end-use is presented in Table X-4.

1. Photography

The largest domestic use of silver is in the production of photographic materials. The light-sensitive properties of silver halides are critical to the manufacture of photographic film for military and civilian applications. This sector accounted for an average of 37 percent of total silver consumption between 1971-1982. Silver consumption in photography was approximately 5 percent less in 1982 than the 1981 level. The decrease has been attributed to the development of substitutes for the silver halides and to technological developments such as nonphotographic diagnostic equipment and electronic cameras.

2. Electrical and Electronic Components

Electrical contacts and conductors accounted for about 29 percent of total consumption in 1982. Silver used as contact metal in switches is highly reliable because of its high conductivity and resistance to oxidation at elevated temperatures. Batteries incorporating silver are used in certain military and aerospace applications and have a long shelf life, high surge voltage under load, and temperature stability.

3. Electroplated Ware, Sterlingware, Jewelry and Arts

Silver consumption in these end uses ranged between 13.7-49.7 million troy ounces between 1971-1981. Silver usage in electroplated ware in 1982 declined by about 64 percent from the 1971 level, and that in sterlingware fell by about 81 percent. The development of new techniques for plating with thinner coats and less waste accounted for the low consumption of silver in electroplated ware. Silver usage in both sterlingware and jewelry is dependent on fashion trends and economic conditions. U.S. consumption of silver in jewelry and arts has

TABLE X-4

U.S. SILVER CONSUMPTION BY END USE

(percent of total consumption)

	1971	1973	1977	1978	1979	1980	1981	1982
Photography	27	26	35	40	42	40	44	39
Electrical and Electronic Components	26	23	24	20	24	27	25	29
Electroplated ware, Sterlingware, and Jewelry and Arts	28	25	21	23	17	16	12	14
Brazing Alloys and Solders	9	9	8	7	7	7	7	7
Other[a]	10	17	12	10	10	10	12	11
Total U.S. Consumption	100%	100%	100%	100%	100%	100%	100%	100%

SOURCE: Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983.

[a] Other includes coinage, coins, medallions, commemorative objects, and catalysts.

generally remained at a low level, averaging about 6.7 million troy ounces between 1971-1981.

4. Brazing Alloys and Solders

Silver-containing brazing alloys are used in refrigeration equipment, electrical equipment, motor vehicles, some aircraft parts, and in plumbing and heat exchanger equipment, all of which have important defense applications. Silver improves the wettability, joint strength, and flow properties of some solders, and silver in brazing alloys can wet various base metals at temperatures below their melting points. Brazing alloys and solders accounted for about 7 percent of total consumption between 1971-1982.

5. Other

Miscellaneous uses accounted for about 11 percent of total consumption in 1982. Miscellaneous uses of silver include silver consumption in coins, medallions, commemorative objects, medicine, and dentistry. The important uses of silver in medicine and dentistry are as antiseptics in the treatment of certain infections and as an amalgam for dental fillings.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

Silver is an internationally traded commodity, with a unified world market where the price is largely determined by worldwide supply and demand forces. Speculation in this precious metals market has also caused some wild fluctuations in prices. The most notorious case in the recent past has been the Hunt episode in 1979, which sent silver prices spiralling upwards before bringing down a total collapse of the market. In December 1979, silver had reached a record high level of $28 per troy ounce. In 1980, the price averaged $20.63 per troy ounce; it subsequently fell by 64 percent to $7.50 per troy ounce in 1982. These prices are still higher than historic average prices. These high prices have led to the exploration and development of previously uneconomic deposits. The secondary silver refiners benefit from high prices because the supply of secondary silver increases during such periods. Domestic and foreign coins, worldwide private and commodity exchange accumulations, and personal accumulations represent the main sources of secondary silver to be reclaimed, smelted, and channeled into industrial production.

A number of secondary refiners have expanded their capacity as a result of high silver prices. For example, Engelhard Corporation substantially expanded its capacity in 1982.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the secondary production of silver will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the 1978-

1982 period. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the secondary silver industry.

The silver price used for this analysis is based on the U.S. price. Historically, U.S. and London market prices have been practically identical. The silver price for the analysis is $12.90 per troy ounce (see Table X-5). The capacity utilization rate is 61 percent (see Table X-6). For both prices and utilization rates, the values used in the analysis show improvement over 1981 and 1982. This assessment is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM). Projections by the BOM show that demand for secondary silver will remain relatively flat through 1990, showing only a slight increase over 1981. (Mineral Commodity Profiles, Bureau of Mines, 1983). The average prices and capacity utilization rates used in this analysis to estimate plant income also show only slight improvement over 1981 values.

These estimates apply to all producers, regardless of whether a plant takes ownership of the silver in the scrap or processes the silver on a toll or fee basis. This is because both the fee charged by a tolling operation and the discount at which a scrap refiner purchases scrap reflect the difference between the market value of scrap and market value of silver. In addition, many scrap refiners frequently operate on a toll basis, depending on market conditions. The similarity of the two types of operation warrants the use of similar prices and capacity utilization.

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the secondary silver industry are described in the Development Document. The treatment options considered for this industry are as follows:

- Option A - This option includes flow reduction via recycle using holding tanks on all scrubber streams, ammonia steam stripping (where required), equalization, chemical precipitation, gravity settling, and partial effluent recycle for floor wash.
- Option B - This option includes Option A plus additional flow reduction of furnace scrubber effluent to achieve zero discharge and flow reduction via cooling tower recycle of casting contact cooling water.
- Option C - This option includes Option B plus multimedia filtration of the effluent.

TABLE X-5

U.S. SILVER PRICES

(dollars per troy ounce)

Year	Actual	1982 Dollars
1978	5.40	7.44
1979	11.09	14.06
1980	20.63	23.92
1981	10.52	11.15
1982	7.95	7.95
	Average =	12.90

SOURCE: Non-Ferrous Metal Data -- 1982,
American Bureau of Metal Statistics, Inc.

TABLE X-6

SECONDARY SILVER CAPACITY UTILIZATION RATES

(million troy ounces)

Year	Production	Capacity[a]	Capacity Utilization (%)
1978	82.9	148.0	56%
1979	94.2	148.0	65%
1980	125.8	148.0	85%
1981	86.4	148.0	58%
1982	64.0	148.0	43%
		Average =	61%

SOURCE: Non-Ferrous Metals Data -- 1982,
American Bureau of Metal Statistics, Inc.

[a] Historical data are not available on industry capacity. Industry sources suggest capacity levels remained relatively constant over the 1978-1982 period.

2. Costs for Existing Plants

Compliance costs for each treatment option have been estimated for each plant and are listed in Table X-7.

H. ECONOMIC IMPACT ANALYSIS

Group ratios calculated from annual reports for this subcategory reflect the financial conditions of large secondary silver producers more accurately than small producers (small plants are defined as having a production capacity of 25,000 troy ounces per year or less). For this reason, separate group ratios were calculated for small plants using the Small Business Administration's FINSTAT data base. The ratio values calculated for small plants are lower than those for large plants.

1. Screening Analysis

The plant-specific compliance costs for the alternative control technologies for each smelter are evaluated against anticipated revenues. If the compliance cost represents more than 1 percent of anticipated revenue, the plant is considered for further analysis.

The results of the screening assessment show that four plants and five product lines are expected to incur total annual costs greater than 1 percent of revenues. A product line refers to a silver producing operation within a plant that manufactures other precious metals. All plants and lines failing the screen were studied in more detail in the closure analysis using the net present value (NPV) test and the liquidity test.

2. Closure Analysis

The four plants and five lines with high compliance costs relative to revenues are analyzed to assess the likelihood of their closure. Applying the methodology described in Chapter II, detailed plant-specific data for individual plants were estimated using the NPV test and the liquidity test.

The liquidity test evaluates a firm's short term viability by examining the short-run (five-year) total cash flow. Under Option C, four product lines are expected to encounter severe cash problems. The results of the liquidity test show that pollution control expenditures cause negative cash flow over a short period for all of these lines. The NPV test evaluates a firm's long-run viability. If the ratio of operating income to plant liquidation value exceeds the real cost of capital for the industry (20.69 percent for large plants, 13.1 percent for small plants), the plant is sound in the long run. The results of the NPV test show that two plants and five lines, four of which were also liquidity test failures, do not pass the test under any of the three regulatory options (see Table X-8).

None of the potential plant or line closures produces more than 1,000 pounds or 14,600 ounces of silver per year. In fact the average

TABLE X-7

SECONDARY SILVER -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs			Total Annual Costs		
	Option A	Option B	Option C	Option A	Option B	Option C
Direct Dischargers						
549	24,062	24,062	28,050	17,834	17,834	19,968
563	0	0	0	264	264	264
611	11,962	11,962	14,437	5,107	5,107	6,364
30927	65,312	65,312	219,312	163,588	163,588	222,237
25	1,100	1,100	1,100	2,868	2,868	3,073
1128	7,975	7,975	14,712	21,144	21,144	23,595
Subtotal	110,411	110,411	277,611	210,806	210,806	275,501
Indirect Dischargers						
74	178,062	178,062	178,062	75,140	75,140	77,905
457	0	0	0	462	462	462
538	73,012	73,012	76,450	26,392	26,392	27,960
4301	29,975	29,975	32,725	9,344	9,344	11,444
9023	3,203	3,203	6,916	2,739	2,739	4,161
1018	0	0	0	66	66	66
1029	50,462	50,462	50,696	13,009	13,075	13,178
1053	2,035	2,035	4,510	3,967	3,967	5,091
1063	30,112	30,112	32,450	12,142	12,142	13,372
1072	1,959	1,993	3,643	1,557	1,562	2,120
1084	2,378	2,378	4,991	2,544	2,544	3,826
1104	2,475	2,475	5,087	1,783	1,783	2,805
1138	0	0	412	505	1,863	2,072
1165	1,237	1,237	1,512	791	791	895
18	5,610	5,610	6,160	2,053	2,053	2,288
1023	1,113	1,113	1,113	347	347	408
460	82	82	110	41	41	54
9020	22,550	34,237	44,412	38,257	41,240	44,798
1092	0	0	115	680	680	719
1100	10,862	10,862	11,687	3,493	3,493	3,978
448	11,770	11,770	13,282	5,111	5,111	5,856
1117	0	0	0	264	264	264
578	31	31	4,569	2,423	2,423	4,593
1164	8,112	8,112	9,075	4,376	4,376	4,821
1167	67,100	67,100	77,825	61,197	61,197	65,254
1204	62,700	62,700	63,937	18,027	18,027	18,523
Subtotal	564,840	576,561	629,739	286,710	291,121	316,915
TOTAL	675,251	686,972	907,350	497,516	501,927	592,416

SOURCE: U.S. Environmental Protection Agency.

TABLE X-8

SECONDARY SILVER -- SUMMARY OF POTENTIAL CLOSURES

	Plants Incurring Cost	Potential Closures			
		Plants	Lines	Total	Total Closures as % of Plants Incurring Cost
Direct Dischargers	6	1	0	1	17
Indirect Dischargers	26	1	5	6	23

capacity for the seven plants and lines is just over 5,000 ounces per year. Two of the lines produce less than 500 ounces per year. The impact of these potential closures on the silver industry is expected to be small because their combined capacity is less than 0.03 percent of that for the industry. Any drop in production from these plants will probably be replaced by other plants.

The five potential line closures are at plants that also produce other precious metals. The value of silver production did not exceed 1 percent of the total value of shipments for any of these plants in 1982. These plants are therefore likely to continue their non-silver operations if these remain profitable. Furthermore, inasmuch as the plants will be covered by other effluent regulations, the actual incremental cost of compliance for the lines mentioned above will probably be less than that estimated for this analysis.

3. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

The cost structure of the plants in the secondary silver industry is highly variable, being strongly dependent upon the type of scrap being utilized and the size of the operation. There is also a great variation in tolling fees as a function of scrap. Limited information indicates that significant economies of scale exist within the industry. The table below summarizes the increase in the cost of production, where the cost of production is assumed to equal plant revenues minus operating income.

	Increase in Cost of Production		
	Option A	Option B	Option C
Direct Dischargers	0.04	0.04	0.05
Indirect Dischargers	0.19	0.19	0.21

The table shows that the maximum increase in cost of production is no more than 0.21 percent. Therefore, additional pollution control expenditures are not expected to have a significant effect on the cost structure of the industry.

b. Price Change

With the increase in the cost of production as a result of pollution control expenditures, producers, in order to maintain profitability, may try to pass compliance costs on to consumers. Even though this pass-through assumption is not used for the screening and closure analyses, here it represents the maximum price increase that could be associated with the increase to cost of production. The table below summarizes the price effects on the secondary silver industry.

	Price Change		
	Option A	Option B	Option C
Direct Dischargers	0.04	0.04	0.05
Indirect Dischargers	0.17	0.17	0.19

The maximum price increase is expected to be low and, therefore, would not have a significant effect on the industry.

c. Change in Return on Investment

Additional pollution control expenditures may affect the profitability of the industry. The change in profitability can be analyzed by examining the change in return on investment (ROI). The potential impact of the compliance costs is shown below.

	Change in Return on Investment		
	Option A	Option B	Option C
Direct Dischargers	-0.44	-0.44	-0.62
Indirect Dischargers	-2.57	-2.61	-2.84

The estimated reduction in revenues is based on the assumption that the industry absorbs all incremental pollution control expenditures. The change in ROI ranges from -0.44 to -2.84, and is not considered a significant factor in plant profitability.

d. Capital Impacts

Secondary silver plants are affected in different ways by the additional capital expenditures required to set up new treatment equipment. The relative differential is rather large, depending on plant size and treatment already in place, and varies from insignificant amounts to $178,062. The table below illustrates the impact of investment compliance costs on plants' ability to finance new plant expenditures.

	Investment Cost as a % of Capital Expenditures		
	Option A	Option B	Option C
Direct Dischargers	1.93	1.93	4.85
Indirect Dischargers	33.48	34.18	37.33

The results show that for some plants the investment compliance costs represent a substantial portion of capital expenditures. This is reflected in the potential closures identified in the closure analysis.

e. Employment Impacts

Employment impacts are measured by the total number of jobs lost at plants expected to close. The two plants and five lines identified as potential closures for Option C are small operations. The total number of jobs lost is estimated to be 62.

This figure represents total employment at the plant and, therefore, overstates the potential number of job losses because, as stated above, only the silver product line has been identified as a potential closure. The impacts on the communities where these plants are located will be minimal since the plants and lines are spread across the country and in any given area represent a small portion of the total community employment.

f. Foreign Trade Impacts

The economic impact of this regulation on foreign trade is the combined effect of price pressure from higher costs and production loss due to potential plant closure. Despite a highly competitive world silver market, price pressure resulting from these regulations is not expected to materialize. Even if domestic producers pass through all compliance costs, prices would rise by at most 0.20 percent. Therefore, no adverse foreign trade effects are anticipated from price pressure. Under the assumption that the seven candidates identified as potential closures do in fact close, and this production is lost to domestic producers, domestic secondary silver capacity will fall by only 37,000 troy ounces. This potentially lost capacity represents less than 0.3 percent of current domestic capacity. A decline in productive capacity of this small magnitude is not expected to significantly affect foreign trade.

CHAPTER XI

PRIMARY COLUMBIUM/TANTALUM

XI. PRIMARY COLUMBIUM/TANTALUM

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States primary columbium/tantalum industry of the cost of alternative pollution control technologies.

Section B of the chapter briefly describes the technology. The structure of the industry, including the size, location, and ownership of the plants is presented in Section C. Section D discusses demand characteristics and end-use markets. Section E describes current trends of the industry. Section F describes price and capacity utilization estimates. Section G contains the cost estimates for the alternative control technologies; Section H presents the results of the economic impact analysis.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise indicated.

B. TECHNOLOGY

Columbium and tantalum have strong geochemical coherence, are closely associated, and are frequently found together, often in association with other minerals.

1. Columbium

Columbium occurs in ores mixed with tantalum in varying degrees, often associated with tin. The columbium content of the ore may range from as high as 83 percent to almost none. Columbium may also be a byproduct of tin smelting, where as much as 14 percent columbium may be present in the slag, together with lesser amounts of tantalum.

Separation by gravity is usually the first step in concentrating the ore, followed by magnetic or electrostatic separation and flotation. Processing depends on the mineral content, which may vary within a single deposit, so most mills are designed for flexibility.

Columbium concentrates, pyrochlore and columbite, may be processed into columbium metal, columbium oxide, columbium carbide and/or ferroalloys. Pyrochlore concentrates have been solely used in the manufacture of ferrocolumbium for steelmaking. Columbite concentrates and related raw materials, on the other hand, are used to make columbium oxide for conversion into other columbium materials.

For production into ferroalloys, the concentrates are generally directly smelted. In the electric furnace process, the concentrates are reduced to metal with silicon or ferrosilicon alloys, and lime or silica. A less common process is the thermite method, which uses aluminum as the reducing agent. In both methods, the reaction product is cooled and crushed, and the alloy is mechanically separated from the slag, ready for marketing.

For production into columbium metal, the ore concentrates are decomposed by fusion with hot sodium hydroxide or, in the case of tin slags, smelted with coke. The product is leached with water and acid, then boiled with hydrofluoric acid.

The columbium and tantalum that remain after filtering can then be separated by the Marignac process, by liquid-liquid extraction, or by fractional distillation. The liquid-liquid, or solvent extraction, process is the most widely used. Columbium compounds are dissolved from an aqueous solution into an organic solvent at a different acidity. Columbium is then precipitated as oxyfluoride and is roasted to produce a pure oxide. Columbium oxide is reduced to metal by the thermite process followed by electron beam melting.

2. Tantalum

Tantalum-bearing ores have been obtained from deposits that frequently contain columbium. Refinable tantalum ore is either high in tantalum and low in unrefinable impurities or is high enough in columbium content to warrant refining both as co-products. Tantalum is also produced as a byproduct of tin mining, from the mineral tantalite.

Processes for obtaining concentrates from ores generally employ flotation and magnetic separation. The concentrates are usually sold on the basis of pentoxide content and percentage of tantalum to total weight.

Production of tantalum from concentrates consists of three production stages: (1) relatively pure intermediate compounds, such as tantalum oxide or potassium tantalum fluoride, are produced from concentrate; (2) the compounds are refined to pure metal powders; and (3) ingot is formed from the powder.

The concentrates are digested with hydrofluoric acid to form fluorides. After filtering to remove undissolved impurities, liquid-liquid extraction is used to separate the mixed fluorides from any remaining dissolved impurities and produce the purified fluoride products.

Potassium tantalum fluoride is reduced to tantalum metal in one of two ways, depending on the desired grade. High quality capacitor-grade powder is made by a sodium reduction process. Electrolytic reduction yields a less pure product suitable for alloys, but this process is not currently practiced.

The final stage is fabrication of ingot into rod, sheet or wire. Depending on circumstances, melting is accomplished either by arc casting or by electron-beam melting.

C. INDUSTRY STRUCTURE

1. Columbium

a. Overview

The United States has been a small producer of columbium since 1959, when small unreported quantities of columbium-bearing concentrates were produced. Production has been from mine operations in South Dakota, as well as from existing stockpiles. In 1982, domestic production of ferrocolumbium, expressed as contained columbium, was down by more than 15 percent from 1981 levels. The value of ferrocolumbium production also decreased, to an estimated $8.6 million. The regular grade was favored over the high-purity grade of ferrocolumbium in the production mix.

The United States has satisfied its columbium requirements primarily by importing the following:

- ferrocolumbium from Brazil (73 percent of total imports in 1982);
- pyrochlore concentrate from Canada (6 percent);
- columbite concentrates from Nigeria;
- tin slags from Malaysia and Thailand (6 percent); and
- synthetic concentrates from the Federal Republic of Germany.

Columbium mineral concentrate imports declined substantially in 1982, reflecting decreased demand. As shown in Table XI-1, 1982 imports fell by 31.53 percent from the 1981 level, and by 43.97 percent from the 1980 level. In 1982, imports for consumption from Brazil included more than 4.8 million pounds of ferrocolumbium with a value of $17.2 million, compared to 9 million pounds valued at $32.6 million in 1981. Imports of columbium oxide from Brazil also declined to 84,000 pounds valued at $468,000, substantially lower than the 1981 totals of 159,000 pounds and $1.3 million. While imports of these raw materials were decreasing, trade volume was up for all export items. The Federal Republic of Germany was the main recipient, with over 70 percent of total shipments.

b. Description of Plants

Columbium is produced in the form of metal, carbide, and oxide. Appreciable amounts of columbium are also used in nickel-, cobalt-, and iron-base superalloys. In 1982, the domestic columbium industry consisted of nine firms with plants at ten locations. Three of these firms were integrated from raw materials processing to columbium end products: Fansteel, Inc. at Muskogee, Oklahoma; Cabot Corporation, KBI Division, at Boyertown, Pennsylvania; and Teledyne Wah Chang, Albany Division, at Albany, Oregon. All three companies produced columbium metal.

Columbium alloys were manufactured by Cabot's KBI division at Revere, Pennsylvania; The Pesses Company at Newton Falls, Ohio;

TABLE XI-1

U.S. IMPORTS AND EXPORTS OF COLUMBIUM

(thousand pounds of columbium content)

Year	Imports[a]	Exports[b]	Net Exports (Imports)
1971	2,526	19	(2,507)
1973	4,669	48	(4,621)
1975	2,939	27	(2,912)
1977	5,108	38	(5,070)
1978	6,577	48	(6,529)
1979	8,342	50	(8,292)
1980	9,728	60	(9,668)
1981	7,960	75	(7,885)
1982[c]	5,450	75	(5,375)

SOURCE: Mineral Commodity Profiles,
U.S. Department of the Interior,
Bureau of Mines, 1983.

[a] Imports include imports of concentrates, ferrocolumbium, tin slags, and other.

[b] Exports include exports of metal, alloys, waste and scrap.

[c] Estimated figures.

Reading Alloys, Inc. at Robesonia, Pennsylvania; Shieldalloy Corporation at Newfield, New Jersey; and Teledyne Wah Chang, Albany Division, at Albany, Oregon.

Mallinckrodt, Inc. was merged into Avon Products, Inc., as a wholly-owned subsidiary in March 1982. Shieldalloy Corporation completed the modernization of its manufacturing facilities at Newfield, New Jersey, enabling it to produce high-purity refractory metals such as columbium and tantalum. NRC Inc. built a new plant at Newton, Massachusetts, to produce columbium mill products in addition to its production of tantalum mill products and powders. Major domestic columbium processing and producing companies and their products are shown in Table XI-2.

Several domestic processors that were originally privately owned are now publicly owned, often as subsidiaries of larger corporations. Examples of such companies are Wah Chang Corporation, Fansteel, Inc., Mallinckrodt, Inc., and KBI. Among privately-owned companies, Shieldalloy is a subsidiary of Metallurg, Inc., of New York. Fansteel and KBI both have interests in foreign operations involving refractory metals and alloys, including columbium.

2. Tantalum

a. Overview

The U.S. has about 3.4 million pounds of tantalum resources. The low-grade resources have been identified in numerous pegmatites and placer deposits in Arizona, Colorado, North Carolina, South Dakota, Utah, New Mexico, and Alaska.

World production of tantalum raw materials averaged approximately 2.0 million pounds per year over the last decade. Between 1979-1981, production increased to 2.6 million pounds per year. This production increase has been attributed to expansion programs in Australia, Brazil, and Canada as a result of increased tantalum raw material prices.

The U.S. has historically been a net importer of tantalum concentrates and tin slags for its primary tantalum supply. Imports of concentrates come chiefly from Canada, Brazil, and Australia for tantalum mineral concentrates, the Federal Republic of Germany for synthetic concentrates, Thailand and Malaysia for tin slags, and a number of other countries for feed material used to produce tantalum products. Additional tantalum powder, metal, waste, and scrap (estimated to contain 70,000 pounds of tantalum) was also imported from other Western European countries and Mexico. The majority of tantalum feedstocks were processed for domestic consumption.

Domestic imports and exports are presented in Table XI-3. Imports in 1980 were approximately 91 percent higher than in 1971, although there have been many fluctuations during this period. Imports in 1982 are expected to fall sharply -- approximately 27 percent below

TABLE XI-2

MAJOR U.S. COLUMBIUM PROCESSING AND PRODUCING COMPANIES - 1982

Company	Plant Location	Products			
		Metal[a]	Carbide	Oxide	Ferro-Columbium/ Nickel-Columbium
Cabot Corporation:					
KBI Division	Boyertown, PA	X	--	X	--
KBI Division	Revere, PA	--	--	--	X
Kennametal, Inc.	Latrobe, PA	--	X	--	--
Metallurg, Inc.: Shieldalloy Corp.	Newfield, NJ	--	X	--	X
Avon Products, Inc.: Mallinckrodt, Inc.	St. Louis, MO	--	--	X	--
NRC, Inc.[b]	Newton, MA	--	--	X	--
The Pesses Co.	Newton Falls, OH	--	--	--	X
H. K. Porter Co., Inc.: Fansteel, Inc.	Muskogee, OK	X	X	X	--
Reading Alloys, Inc.	Robesonia, PA	--	--	--	X
Teledyne, Inc.: Teledyne Wah Chang Albany Division	Albany, OR	X	X	X	X

SOURCE: Minerals Yearbook, U.S. Department of the Interior, Bureau of Mines, 1982.

[a] Includes miscellaneous alloys.

[b] Jointly owned by South American Consolidated Enterprises, S.A. and H.C. Starck Berlin.

TABLE XI-3

U.S. IMPORTS AND EXPORTS OF TANTALUM

(thousand pounds of tantalum content)

Year	Imports	Exports	Net Exports (Imports)
1971	1,023	201	(822)
1974	1,730	435	(1,295)
1975	933	428	(505)
1977	2,058	539	(1,519)
1978	1,409	607	(802)
1979	1,914	721	(1,193)
1980	2,280	706	(1,574)
1981	1,580	222	(1,358)
1982[a]	1,160	400	(760)

SOURCE: Mineral Commodity Profiles and Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983.

[a] Estimate.

1981 levels and approximately 50 percent below 1980 levels -- primarily as a result of the 1981-1982 worldwide economic recession. However, the U.S. exported fairly large amounts of tantalum to Western European countries and Japan in 1982, when exports were about 80 percent higher than in 1981.

b. Description of Plants

The domestic tantalum industry consists of seven firms with plants at eight locations. Table XI-4 lists the major processing and producing companies and their products. NRC Inc. is almost totally committed to the production and processing of tantalum powder and metal. Kennametal, Inc. and Shieldalloy Corporation mainly produce tantalum carbide. The main tantalum products at Mallinckrodt, Inc. are potassium fluotantalate and tantalum oxide, both intermediate products used by other firms to make tantalum metal and other end products. Two of these firms, Fansteel, Inc., and the KBI Division of Cabot Corporation, are integrated from raw materials processing through to tantalum end products.

D. DEMAND

1. Columbium

Columbium is classified as a defense-related strategic and critical material, because of its uses in the aerospace, energy, and transportation industries. Almost all columbium is used in the form of ferrocolumbium, and more rarely in the form of pentoxide, in the manufacture of alloy steels. Columbium oxide itself is not considered strategic, but it is the principal non-metallic form in which columbium has been used. The largest demand for columbium oxide has been as an intermediate in the manufacture of high-purity ferrocolumbium, nickel-columbium, columbium metal, and columbium carbide. Columbium carbide is used in steel-cutting grade cemented carbide tools. Columbium consumption by end-use is presented in Table XI-5.

a. Construction

Steelmaking has accounted for about four-fifths of domestic columbium consumption in recent years. Columbium's corrosion resistance enhances its use in exhaust manifolds, pressure vessels, and fire walls. Columbium-bearing HSLA steels (also called high-strength, low-alloy steels) have been increasingly used for structural purposes in buildings and bridges. Construction has been the largest single demand sector, accounting for about 36-40 percent of total columbium consumption.

b. Machinery

This sector has historically accounted for about 15-16 percent of total consumption of columbium, though, in the early 1970s, its share was around 20 percent. Columbium is used in the manufacture of heavy mining equipment such as rock cutters, and also for machine components where shock resistance is required.

TABLE XI-4

MAJOR U.S. TANTALUM PROCESSING AND PRODUCING COMPANIES

Company	Plant Location	Products		
		Metal[a]	Carbide	Oxide
Cabot Corp.: KBI Div.	Boyertown, PA	X	--	X
Kennametal, Inc.	Latrobe, PA	X	X	X
Avon Products, Inc.: Mallinckrodt, Inc.	St. Louis, MO	--	--	X
Metallurg, Inc.: Shieldalloy Corp.	Newfield, NJ	X	X	--
NRC Inc.[b]	Newton, MA	X	--	--
H. K. Porter Co., Inc.: Fansteel, Inc.	Muskogee, OK	X	X	X
Fansteel, Inc.	N. Chicago, IL	X	--	--
Teledyne Inc.: Teledyne Wah Chang Albany Div.	Albany, OR	X	--	--

SOURCE: Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983.

[a] Includes miscellaneous alloys.

[b] Jointly owned by South American Consolidated Enterprises, S.A., and H. C. Stark Berlin.

TABLE XI-5

U.S. COLUMBIUM DEMAND PATTERN

(percent of total demand)

	1971	1974	1975	1977	1978	1979	1980	1981	1982
Construction	36.39	37.97	39.99	35.10	34.01	33.00	31.05	38.99	39
Machinery	20.00	20.00	15.00	14.51	13.97	12.99	10.95	14.00	14
Oil & Gas Industries	21.59	20.00	19.99	16.20	16.02	14.00	15.99	20.00	20
Transportation	17.99	18.00	19.99	23.19	23.99	31.99	31.98	20.00	20
Other	4.01	4.00	5.01	10.99	11.99	8.00	10.00	6.99	7
Total	100	100	100	100	100	100	100	100	100

SOURCE: Mineral Commodity Profiles and Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983.

Detail may not add to total because of rounding.

c. Oil and Gas

The strength and toughness of the HSLA steels has made them attractive for use in oil and gas pipelines. One effect of the 1974 oil price rise has been to greatly encourage the construction of oil pipelines, creating an unforeseen demand for columbium. This sector accounted for about 20 percent of total columbium consumption.

d. Transportation

Columbium use in transportation has been spurred by the aerospace industry, due to the development of coatings resistant to oxidation at high temperatures. High strength steels have also been used in both private and public transportation vehicles. This sector accounted for 20 percent of total columbium consumption in 1982, down by over 12 percent from the 1980 level.

e. Other

Minor uses for the metal occur in the nuclear energy and electronics industries. Columbium is used as a construction material in nuclear reactors because of the resistance to super-heated water, to liquid sodium and to other metals. This sector accounted for about 7 percent of total consumption in 1982. Between 1971-1982, this sector's share has ranged between 4-12 percent.

2. Tantalum

The two most important domestic tantalum demand sectors during the past five years have been electronic components and metal-working machinery, which together accounted for four-fifths of consumption. Total world tantalum demand in 1981 is estimated to be about 2 million pounds, with the U.S. consuming about 62 percent of the total. As shown in Table IX-6, domestic consumption is categorized into three main markets: electronics (65 percent), machinery (24 percent), and transportation (9 percent). Other uses constitute 2 percent of the tantalum market between 1971-1981.

a. Electronics

The tantalum capacitor has become the standard for capacitors used in electronic systems; this market accounted for approximately 70 percent of the tantalum consumed in 1982. Tantalum in this sector is used in the form of powder produced from tantalum oxide by first converting the oxide to fluoride. It is also used to produce components such as contact points and electrodes.

b. Metal-Working Machinery

This sector is the second largest category of tantalum use in the United States, accounting for about 22 percent of total consumption in 1982. Tantalum carbide, mostly in mixtures with carbides

TABLE XI-6

U.S. TANTALUM CONSUMPTION BY END USE

(percent of total consumption)

	1971	1974	1975	1977	1978	1979	1980	1981[a]	1982[a]
Electronic components	46	69	63	66	68	66	73	70	70
Transportation	22	8	6	6	6	8	6	8	8
Machinery	27	21	28	27	25	26	19	22	22
Other	5	2	3	1	1	--[b]	2	--[b]	1
Total	100	100	100	100	100	100	100	100	100

SOURCE: Mineral Commodity Profiles and Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983.

[a] Estimated.

[b] Less than .05 percent.

of such metals as tungsten, titanium, and columbium, is used in cutting tools, wear-resistant parts, dies, turning and boring tools, milling cutters, and lathe centers. Tantalum's corrosion resistance has found many applications in the chemical industry, where it is used to make pipes, crucibles, retorts, etc.

c. Transportation

About 8 percent of the total tantalum consumed in 1982 was used in aerospace and other transportation applications. Demand for tantalum in transportation applications decreased markedly in the last decade. Increased aircraft production and greater diversity of uses in superalloys could, however, reverse the trend.

d. Other

Miscellaneous uses ordinarily account for 1-2 percent of total demand. In 1982, consumption of tantalum in other uses such as nuclear reactors, optical glass, laboratory ware, and electroplating devices, was responsible for less than 1 percent of the total consumption in 1982.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

1. Columbium

In recent years, columbium producer prices have risen steadily in line with the growth of consumption and inflation. The real price has, therefore, remained relatively stable. The price for standard grade ferrocolumbium, which had increased moderately over the last decade, decreased 11 percent in midyear 1982 to about $6 per pound of columbium content. Brazil's largest producer of pyrochlore concentrates, CBMM, entered the high-purity ferrocolumbium market at midyear; as a result, the price for high-purity grade ferrocolumbium declined 4 percent.

Columbium has not been particularly popular with metal merchants in the past, due mainly to the efficient and flexible pricing policy of main producers who can adjust prices and stocks according to demand. Most producers either sell directly to consumers or have local agents to market their product. International merchant activity is apparent only during temporary shortages of material.

2. Tantalum

U.S. tantalum supply depends to a large degree upon maintenance of a stable price for tantalum and its co-products, principally tin and columbium. Some tantalum mining operations are high-cost operations and only relatively high prices can maintain their production or bring new ones onstream. A steep rise in the price of tantalum between 1978-1980, from $44 per pound to $138 per pound, stimulated the discovery of new, relatively large tantalum resources. Tantalum product prices rose as a result of the high raw materials prices. However, low midyear 1983 tantalum prices (the lowest since 1977) and weak demand have resulted in the shutdown of one major tantalum mine and an overall cutback in others. The spot market price for tantalum concentrates which began 1982 at nearly $40 per pound of contained pentoxide was down to about $35 by midyear, and was quoted in the fourth quarter at around $25, as demand dropped further. The price for capacitor-grade tantalum powder was lowered about 7 percent at midyear, and subsequently decreased in the fourth quarter by an estimated 6-10 percent.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the production of columbium and tantalum will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on average prices and capacity utilization rates. The average price for columbium and tantalum is based on the 1978-1982 period. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the columbium/tantalum industry. Historical capacity and production information is not available. Therefore, the capacity utilization rate for 1982 is used as a conservative estimate of the industry's long-term potential. The rates for 1982 are calculated as follows:

	Columbium	Tantalum
Capacity (pounds)	2,800,000	2,000,000
Production (pounds)	1,720,000	1,000,000
Capacity Utilization (percent)	61	50

SOURCE: U.S. Department of the Interior, Bureau of Mines, 1983.

The columbium and tantalum prices for the analysis are $5.04 and $89.87 per pound, respectively (see Table XI-7). The prices used in the analysis show improvement over 1982. This assessment is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM), which shows an overall improvement in the columbium/tantalum industry. Specifically, the BOM projects columbium demand to increase at an average annual rate of 5 percent, and tantalum demand to increase by 3 percent, from 1981 to 2000 (Mineral Commodity Profiles, Bureau of Mines, 1983).

TABLE XI-7

U.S. COLUMBIUM AND TANTALUM PRICES

(dollars per pound of contained columbium/tantalum)

Year	Constant 1982 Dollars	
	Columbium Prices	Tantalum Prices
1978	5.08	47.11
1979	4.84	101.40
1980	5.24	146.54
1981	5.19	105.48
1982	4.86	48.84
Average prices:	5.04	89.87

SOURCE: *Mineral Commodity Profiles*,
U.S. Department of the Interior,
Bureau of Census, 1983.

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the columbium and tantalum industries are described in the Development Document. The treatment options considered for these industries are as follows:

- Option A - This option includes ammonia steam stripping, equalization, chemical precipitation, and gravity settling.
- Option B - This option includes Option A plus flow reduction of all scrubber waters (except reduction of tantalum salt to metal scrubber liquor) via a holding tank and recycle system, and lime and settle treatment.
- Option C - This option includes Option B plus multimedia filtration of the final effluent.

2. Costs for Existing Plants

Five columbium/tantalum plants are expected to incur costs subject to compliance with this regulation. They include both direct and indirect dischargers. Table XI-8 presents the investment and total annual compliance costs for the columbium/tantalum industry.

Of the five plants incurring costs, one produces only columbium and another produces only tantalum. The remaining three plants produce both products in varying amounts. Product prices and capacity utilization rates are attributed to these plants in proportion to the ratio of columbium and tantalum production. Compliance costs are based on the combined production of both metals.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

Estimates of the plant-specific compliance costs presented in Table XI-8 are used to assess the probability of plant closures. Individual plants are first screened to identify plants for further analysis. The total annual compliance costs are evaluated against plant-specific estimated revenues. If the compliance cost represents more than 1 percent of anticipated revenue, the plant is considered for further analysis.

The results of the screening assessment show that one plant has annual costs greater than 1 percent of its annual revenues, for all three options, while two other plants have annual costs greater than 1 percent of revenues for Option C only.

2. Plant Closure Analysis

Plants identified in the screening analysis were first studied using the liquidity test. The test results indicate that all the plants

TABLE XI-8

PRIMARY COLUMBIUM/TANTALUM -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs			Total Annual Costs		
	Option A	Option B	Option C	Option A	Option B	Option C
Direct Dischargers						
507	0	32,312	66,962	308,061	314,640	327,403
519	658,487	661,925	701,937	440,896	443,404	458,481
4225	21,037	41,937	60,775	28,337	32,950	38,684
Subtotal	679,524	736,174	829,674	777,295	790,994	824,567
Indirect Dischargers						
509	693,000	721,462	745,662	368,909	375,001	383,643
513	257,837	257,837	289,187	106,230	106,230	117,473
Subtotal	950,837	979,299	1,034,849	475,139	481,232	501,115
Total	1,630,361	1,715,473	1,864,523	1,252,434	1,272,226	1,325,683

SOURCE: U.S. Environmental Protection Agency.

have positive cash flows even under the most costly alternative. That is, the pollution control expenditures do not have a significant impact on the short-term (five-year) liquidity of the plants.

The NPV test compares a plant's ratio of operating income to liquidation value to the real cost of capital for the industry. If the ratio of income to liquidation value, as defined in Chapter II, is less than the threshold value of 16.69 percent, the plant is a potential closure. The NPV test shows that no plant has a ratio of less than 16.69 percent under any option, and hence, no plants are expected to close.

3. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

The effect of regulatory compliance costs on the financial performance of the columbium/tantalum industry is evaluated in terms of the increase in the cost of production. Since the plant-specific unit cost of production is not known, an estimate of the cost of production is sales minus operating income. The following table gives an estimate of the increase in the cost of production for the three options.

	Increase in of Cost of Production		
	Option A	Option B	Option C
Direct Dischargers	1.41	1.44	1.50
Indirect Dischargers	0.69	0.70	0.72

As shown in the table, the maximum increase in the cost of production is less than 1.5 percent and is not considered to be significant.

b. Price Change

The additional compliance costs evaluated against the annual revenues of the plants have been used to estimate the increase in price of columbium/tantalum under the assumption of full pass-through of costs. The price effect has been summarized in the following table. The assumption of complete cost pass-through is not used in the closure or screening analyses.

	Price Change		
	Option A	Option B	Option C
Direct Dischargers	1.29	1.32	1.37
Indirect Dischargers	0.63	0.64	0.66

The results indicate that if all compliance costs could be passed on to customers, the maximum price increase would be 1.37 percent. This amount is not likely to adversely impact the competitiveness of the columbium/tantalum producers subject to this regulation.

c. Change in Return on Investment

With the increase in the cost of production, the potential decrease in industry profitability is estimated in direct proportion to the increase in compliance costs. The following table presents the estimated decrease in the overall profitability in terms of return on investment (ROI).

	Change in Return on Investment		
	Option A	Option B	Option C
Direct Dischargers	-17.11	-17.52	-18.41
Indirect Dischargers	- 9.65	- 9.80	-10.23

The decrease in profitability represented by the above results is not expected to cause a significant impact on plant profitability.

d. Capital Impacts

The additional capital costs imposed by the regulatory options for each of the columbium/tantalum plants have been evaluated against the annual capital expenditures of the plants. The results are summarized below.

	Investment Cost as a % of Capital Expenditures		
	Option A	Option B	Option C
Direct Dischargers	25.03	27.12	30.57
Indirect Dischargers	27.82	28.65	30.28

The table shows that incremental investment costs are between 25-31 percent of annual capital expenditures under each of the three options. Costs of this magnitude should not have an adverse impact on the availability of funds for other capital projects.

e. Employment Impacts

Employment impacts of the regulatory costs have been examined in the context of plant closures. For small production decreases, there is generally no change in capacity. Only major production changes arising due to plant closures are expected to have a direct effect on employment levels. Because no plants are expected to close, no employment impacts are expected.

f. Foreign Trade Impacts

The economic impact of the compliance costs on the balance of trade is analyzed in relation to changes in domestic price and production. Because there are no expected closures, and only minor price impacts, the regulations are expected to have minimal impacts on the balance of trade.

CHAPTER XII

PRIMARY TUNGSTEN

XII. PRIMARY TUNGSTEN

A. INTRODUCTION

This chapter presents an analysis of the economic impact on the United States primary tungsten industry of the cost of alternative pollution control technologies.

The technology used to produce tungsten from ore is briefly discussed in Section B. The structure of the industry is presented in Section C. The demand and end-use markets for tungsten are discussed in Section D; Section E discusses current trends of the industry. Section F presents estimates for prices and capacity utilization. Section G presents the cost estimates for the alternative control technologies. The economic impact results are discussed in Section H.

All compliance cost and economic impact information is stated in 1982 dollars unless otherwise indicated.

B. TECHNOLOGY

Because of the complexity of tungsten ores, tungsten is traded mainly in the intermediate forms of the metal. These are concentrates (wolframite and scheelite), ferro-tungsten, and ammonium paratungstate (APT). Practically all tungsten concentrates are produced by very simple flotation and gravitational separation from the ore. Ferrotungsten is either produced by the normal alumino thermic method (reduced from the ore with aluminum powder in the presence of iron) or by reduction in an electric ore furnace. Tungsten scrap is usually the stock for the latter method.

Most pure tungsten is produced in powder form from APT. The production of APT requires chemical treatment of the concentrates in addition to the physical concentration. Separation of tungsten from molybdenum and other byproducts, as well as treatment of slimes and products not amenable to complete concentration by physical means, also necessitate chemical treatment. Tungsten powder is produced from APT by reducing it with hydrogen. The powder is then compacted into the final desired shape (wire, rod or sheet) by compressing, sintering and heating.

C. INDUSTRY STRUCTURE

1. Overview

The United States plays a fairly active role in the world tungsten market, consuming about 20 percent of the world's tungsten concentrate production. The People's Republic of China, the U.S.S.R., the United States, and Australia are the four largest producers, together accounting for approximately 56-60 percent of world mine production.

Domestic tungsten supply comes from the production of primary and secondary material, shipments from excesses in government stockpiles, imports, and industry stocks. The United States is becoming increasingly dependent on imports and government stockpile releases. The General Services Administration (GSA) manages the American strategic stockpile, and retains large stocks of tungsten in various forms. This material is currently made available to buyers in regular official sales.

Imports of tungsten concentrate and intermediate products for consumption were at their lowest levels since 1972. As indicated in Table XII-1, imports of concentrate fell 34 percent from 11.75 million pounds in 1981 to 7.8 million pounds in 1982. During 1978-1981, net import reliance as a percent of apparent consumption was at a low of 50 percent in 1981, down from a high of 58 percent in 1979. Exports of tungsten in concentrate and primary products decreased 15 percent from 5.2 million pounds in 1981 to 4.4 million pounds in 1982. Exports of tungsten in concentrate fell precipitously from a high of 2.029 million pounds in 1980 to a low of 0.175 million pounds in 1981. Exports recovered in 1982 to reach a level of 0.672 million pounds.

2. Description of Plants

Table XII-2 lists the major domestic companies engaged in tungsten operations since 1982. The Union Carbide Corporation, the largest U.S. tungsten producer, is integrated vertically from mining to the manufacture of tungsten intermediate products. It is also the only producer of ferro-tungsten, and the largest domestic producer of ammonium paratungstate. Teledyne Tungsten began production of tungsten concentrate at a full capacity rate in mid-1978.

D. TUNGSTEN DEMAND

Tungsten is a typical example of a vitally important raw material which is produced mainly in third-world countries, but consumed mainly in the industrialized countries. Tungsten-containing products have diverse applications throughout the economy. These products are found in automobiles, airplanes, appliances, electric lamps, paints, petroleum catalysts, and many other end uses. Substitution on a large scale with other materials in these uses is very difficult. Specific end-use categories are discussed in detail below.

1. Metal-Working, Mining, and Construction Machinery

Tungsten is an extremely hard substance and does not oxidize at high temperatures. It is, therefore, used primarily in the production of high-speed steels and tool-and-die (cold-and-hot-work) steels, which are used as cutting tools. Cutting and wear-resistant materials represent the major market for tungsten carbide, accounting for practically all carbide consumption and about half of all tungsten metal powder consumption. New metal-shaping methods, such as laser and mining machinery may, however, reduce tungsten use in this field.

TABLE XII-1

U.S. TUNGSTEN IMPORTS AND EXPORTS

(thousand pounds of tungsten content)

Year	Imports for Consumption[a]	Exports[a]	Net Exports (Imports)
1977	6,919	1,283	(5,636)
1978	9,138	1,853	(7,285)
1979	11,352	1,929	(9,423)
1980	11,372	2,029	(9,343)
1981	11,752	175	(11,577)
1982	7,778	672	(7,106)

SOURCE: *Mineral Commodity Summaries*, U.S. Department of the Interior, Bureau of Mines, 1983.

[a] Imports and exports of tungsten concentrate.

TABLE XII-2

MAJOR U.S. TUNGSTEN PRODUCERS

Company	Location of Mine, Mill, or Processing Plant
Producers of Tungsten Concentrate:	
Climax Molybdenum Co., A Div. of AMAX, Inc.	Climax, CO
Teledyne Tungsten	North Fork, CA
Union Carbide Corp., Metals Div.	Bishop, CA & Tempiute, NV
Utah International, Inc.	Imlay, NV
Processors of Tungsten:	
AMAX, Inc., AMAX Tungsten Div.	Fort Madison, IA
Adamas Carbide Corporation	Kenilworth, NJ
Fansteel, Inc.	North Chicago, IL
General Electric Co.	Euclid, OH & Detroit, MI
GTE Products Corporation	Towanda, PA
Kennametal, Inc.	Latrobe, PA & Fallon, NV
Li Tungsten Corporation	Glen Cove, NY
North American Phillips Lighting Corp.	Bloomfield, NJ
Teledyne Firth Sterling	McKeesport, PA
Teledyne Wah Chang Huntsville	Huntsville, AL
Union Carbide Corporation, Metals Div.	Niagara Falls, NY

SOURCE: Mineral Commodity Profiles, United States Department of the Interior, Bureau of Mines, 1983.

Production of mining machinery and equipment stemmed from the energy crisis. Tungsten, with its characteristic hardness and resistance to oxidation at high temperatures, found a major application in the development of such equipment to perform necessary deep exploration and mining of various fuels. The growth in tungsten demand was further enhanced by construction of the national interstate highway network. This sector accounted for 72 percent of total tungsten consumption in 1982.

2. Transportation

Tungsten in the transportation sector is used principally in superalloys and as heat-and-abrasion-resisting cladding on high-temperature components of gas turbines and jet engines, primarily in contact points. Gas turbines are used mainly in the aircraft industry; automotive applications are also being developed. This sector accounted for about 11 percent of all tungsten consumed in 1982.

3. Lamps and Lighting

There is no satisfactory substitute for tungsten in this sector. Tungsten wire is used for filaments in incandescent lamps and for heating elements in fluorescent lamps and vacuum tubes. The amount of tungsten used in fluorescent-type and wall panel lighting is essentially the same as that used in lamp filaments except that more light is provided at lower cost by fluorescent lighting. This sector accounted for 8 percent of total tungsten consumption in 1982.

4. Electrical

Tungsten demand in electrical uses is based on the degree of high-temperature and wear resistance required for current applications such as contact points. There are no satisfactory substitutes for tungsten's wear resistance. Where lower temperatures are involved, however, molybdenum-tungsten alloys are preferred. Electrical uses accounted for 5 percent of total tungsten consumption in 1982.

5. Other Uses

Miscellaneous uses of tungsten include some chemical applications such as dyes, phosphors, reagents, and corrosion-inhibitors. Tungsten is also consumed for chemical vapor deposition (CVD), as a catalyst in chemical processing, and as self-lubricating powder-metal compacts. Tungsten is also used for kinetic penetration; however, in this market it competes with depleted uranium. In 1982, miscellaneous uses accounted for 4 percent of total tungsten consumed in the United States.

E. CURRENT TRENDS -- CAPACITY UTILIZATION AND PRICES

The tungsten market is controlled by international merchants. The market is extremely volatile and highly speculative. The international price is relatively unaffected by domestic demand because of the large size of the international market. The U.S. market price, therefore, hovers around the international price. The difference, if any, is due to the import duty and transportation charges.

The price of concentrate in current dollars was unusually stable from 1978 until October 1981, when it began a decline that extended through 1982. Prices fell approximately 25 percent from the 1981 levels, reflecting the general economic downturn in 1982.

Low prices and a substantially reduced demand led to low capacity utilization in the domestic tungsten industry in 1982. Mine capacity utilization in 1982 was only 35 percent. The Pine Creek Mine, which had been the largest producer, operated at a reduced capacity from April 1982 until its closure in early August. An improved demand for tungsten is expected for the near future due to an increase in industrial capital investment, expanded automobile production, expanding applications of tungsten-using materials, an increase in expenditure on armaments, and generally better economic conditions in the near future.

F. ESTIMATES OF PRICES AND CAPACITY UTILIZATION

It is assumed, for purposes of this analysis, that plants engaged in the production of tungsten will experience constant real incomes over the lifetime of the compliance equipment. The income level used is based on the average prices and capacity utilization rates for the 1978-1982 period. This period was selected because it represents a complete business cycle with a peak year in 1979 and a recession in 1982. The period reflects the long-term potential for the tungsten industry.

The tungsten price used for this analysis is based on the U.S. price. As discussed in the previous section, U.S. producer prices have historically been close to the international market price. The tungsten price used for the analysis is $9.15 per pound (see Table XII-3). The capacity utilization rate is 86 percent (see Table XII-4). For both prices and utilization rates, the values used in the analysis show improvement over 1982. This assessment is consistent with publicly available information from the Department of the Interior's Bureau of Mines (BOM), which shows an overall improvement in the tungsten industry. Specifically, the BOM projects tungsten demand to increase at an average annual rate of 3 percent from 1981 to 2000 (Minerals Yearbook, Bureau of Mines, 1982).

TABLE XII-3

U.S. TUNGSTEN PRICES

(dollars per pound)

Year	Average Annual Price	
	Actual Prices	1982 Dollars
1978	8.08	11.13
1979	8.03	10.18
1980	8.26	9.58
1981	8.21	8.70
1982	6.18	6.18
		Average = 9.15

SOURCE: Mineral Commodity Profiles and Mineral Commodity Summaries, U.S. Department of the Interior, Bureau of Mines, 1983.

TABLE XII-4

PRIMARY TUNGSTEN PRODUCTION AND CAPACITY
(000 pounds metal powder)

Year	Production	Capacity[a]	Capacity Utilization
1978	16,548	20,000	83%
1979	18,426	20,000	92%
1980	18,116	20,000	91%
1981	19,754	20,000	99%
1982	13,425	20,000	67%
		Average =	86%

SOURCE: Production data -- Mineral Commodity Profiles, U.S. Department of the Interior, Bureau of Mines, 1983. Capacity data (1982) -- Personal communication, U.S. Department of the Interior, Bureau of Mines.

[a] Historical data are not available on industry capacity. Industry sources suggest capacity levels remained relatively constant over the 1978-1982 period.

G. EFFLUENT CONTROL GUIDELINES AND COSTS

1. Regulatory Alternatives

Process-related wastewater sources in the tungsten industry are described in the Development Document. The treatment options considered for this industry are as follows:

- Option A - This option includes ammonia steam stripping, equalization, chemical precipitation, gravity settling, and vacuum filtration.
- Option B - This option includes Option A plus flow reduction of all scrubber wastestreams via a holding tank and recycle system, and lime and settle treatment.
- Option C - This option includes Option B plus multimedia filtration of the final effluent.

2. Costs for Existing Plants

Ten primary tungsten plants are expected to incur costs for compliance with this regulation. They include four direct dischargers and six indirect dischargers. Table XII-5 shows the total annual and investment compliance costs, by discharge status and treatment option.

H. ECONOMIC IMPACT ANALYSIS

1. Screening Analysis

The plant-specific compliance costs presented above for existing sources are used to assess the probability of plant closures using the methodology presented in Chapter II. Individual plants are screened to identify plants for further analysis. Total annual compliance costs as a percent of plant annual revenues is the screen used to identify plants that might face difficulties with pollution control costs. The threshold value for this screen is 1 percent. If total annual compliance costs for a plant represent less than 1 percent of revenues, the plant is clearly not a high-impact case and is not analyzed further.

The results of the screening assessment show that for each option, one direct and one indirect discharger exceed the threshold of 1 percent.

2. Plant Closure Analysis

The two plants which do not pass the screen are further analyzed by using the liquidity test and the net present value (NPV) test. The liquidity test judges the short-run viability of the firm. If the pollution control expenditures cause a negative cash flow over a short period (five years), the plant does not have adequate cash reserves to meet short-term contingencies.

TABLE XII-5

PRIMARY TUNGSTEN -- COMPLIANCE COST ESTIMATES

(1982 dollars)

Plant ID Number	Investment Costs			Total Annual Costs		
	Option A	Option B	Option C	Option A	Option B	Option C
Direct Dischargers						
9012	257,125	257,125	322,025	355,012	355,012	378,592
9014	261,525	266,062	298,512	162,737	163,804	175,131
9026	8,525	8,525	10,862	5,774	5,774	7,439
9031	155,087	155,087	142,037	113,409	113,409	122,869
Subtotal	642,262	646,799	773,436	636,932	637,998	684,031
Indirect Dischargers						
9010	10,450	10,450	12,925	5,464	5,464	6,952
9011	208,312	208,312	257,537	186,160	186,160	204,256
9018	110,137	110,137	113,575	33,193	33,193	35,747
9025	75,762	75,762	78,100	23,693	23,693	24,830
9028	6,187	6,187	8,662	4,240	4,240	5,728
9029	92,812	92,812	96,800	28,390	28,390	30,299
Subtotal	503,660	503,660	567,599	281,139	281,139	307,811
Total	1,145,922	1,150,459	1,341,035	918,070	919,137	991,841

SOURCE: U.S. Environmental Protection Agency.
Detail may not add to total because of rounding.

For the NPV test, if net income as a percent of the liquidation value of the assets (as defined in Chapter II) is greater than the real cost of capital for the industry (14.66 percent), the plant will probably continue in operation.

The results of the NPV test show that, at each treatment option, the ratio of net income to plant liquidation value exceeds the threshold of 14.66 percent. Also, all cash flow values are positive for the short-run liquidity test. These results demonstrate that the costs of compliance will not cause any plant closures in the primary tungsten industry.

3. Other Impacts

In addition to closures, other impacts on the industry have been assessed. These include:

- increase in cost of production;
- price change;
- change in return on investment;
- capital impacts;
- employment impacts; and
- foreign trade impacts.

a. Increase in Cost of Production

This impact is measured by calculating the ratio of total annual compliance costs to the total cost of production. Cost of production is assumed to equal revenues minus the operating income of a plant. This ratio represents the percent increase in production costs due to the compliance expenditures. The table below presents the average increases for each option.

	Increase in Cost of Production		
	Option A	Option B	Option C
Direct Dischargers	1.05	1.05	1.13
Indirect Dischargers	0.43	0.43	0.47

These results indicate that the annual costs due to this regulation will increase operating costs by no more than 1.13 percent for any treatment option. This amount is not expected to significantly affect the structure of the industry.

b. Price Change

This change is expressed as the ratio of total annual compliance costs to total plant revenues. This ratio represents the percent increase in price a plant will have to impose to pass through the entire cost of these regulations. The following table shows the average price increases under each option. The assumption of complete cost pass-through is not used in the closure or screening analyses.

	Price Change		
	Option A	Option B	Option C
Direct Dischargers	0.90	0.90	0.97
Indirect Dischargers	0.36	0.36	0.40

Price increases of less than 1.0 percent would be sufficient to pass through the entire cost of these regulations for the primary tungsten industry. This amount is not likely to adversely impact the competitiveness of the tungsten plants subject to this regulation.

c. Change in Return on Investment

Return on investment (ROI) is expressed as net income divided by total assets. For this regulation, the change in ROI is as follows:

	Change in Return on Investment		
	Option A	Option B	Option C
Direct Dischargers	-7.17	-7.19	-7.80
Indirect Dischargers	-3.20	-3.20	-3.52

Rates of return on investment for the industry are expected to decrease by 7.8 percent or less for all plants at all treatment options. This does not represent a significant impact on future earnings potential for plants in the primary tungsten industry.

d. Capital Impacts

For the primary tungsten industry, the average ratios of investment costs to capital expenditures are as follows:

	Investment Cost as a % of Capital Expenditures		
	Option A	Option B	Option C
Direct Dischargers	10.03	10.10	12.08
Indirect Dischargers	7.21	7.21	8.13

These results show that primary tungsten plants will incur costs due to this regulation of no more than 12.08 percent of their average annual capital expenditures. These compliance costs, therefore, will not impose restrictions on funds available for new production equipment.

e. Employment Impacts

Employment impacts of the regulatory costs have been examined in the context of plant closures. For small production decreases, there is generally no change in capacity. Only major production changes arising due to plant closures are expected to have a direct effect on employment levels. Because no plants are expected to close, no employment impacts are expected.

f. Foreign Trade Impacts

Despite the highly competitive nature of the world market for tungsten products, very small increases in production costs and prices, which are detailed above, are not expected to materially reduce competitiveness or affect the balance of trade.

CHAPTER XIII

NEW SOURCE IMPACTS

XIII. NEW SOURCE IMPACTS

The basis for new source performance standards (NSPS) and pretreatment standards for new sources (PSNS) as established under Section 306 of the Clean Water Act is the best available demonstrated control technology. Builders of new facilities have the opportunity to install the best available production processes and wastewater treatment technologies, without incurring the added costs and restrictions encountered in retrofitting an existing facility. Therefore, Congress directed EPA to require that the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies be installed in new facilities. For regulatory purposes new sources include greenfield plants and major modifications to existing plants.

The potential economic impact of concern to EPA in evaluating new source regulations is the extent to which these regulations represent a barrier to the construction of new facilities or exert pressures on existing plants to modernize, and thereby reduce the growth potential of the industry.

In evaluating the potential economic impact of the NSPS/PSNS regulations on new sources, it is necessary to consider the costs of the regulations relative to the costs incurred by existing sources under the BAT/PSES regulations, and whether the methodology used to estimate the impacts of the BAT/PSES regulations is appropriate for estimating the impacts of the NSPS/PSNS regulations.

Regarding the costs of the NSPS/PSNS regulations, the Agency has determined that the regulations are not significantly more costly. The technology basis of the new source regulations is the same as for existing sources but with additional flow reduction for some subcategories. There is no incremental cost associated with these additional flow reductions, however, and new sources will therefore not be operating at a cost disadvantage relative to existing sources due to the regulations.

Regarding the applicability of the economic impact analysis methodology to the new source regulations, the methodology is applicable because the financial tests of plant closure are based on inflation-adjusted values of assets and net income and not book values.

Given that the costs incurred under the NSPS/PSNS regulations are not significantly different than those incurred under the BAT/PSES regulations, and that the economic impact analysis methodology is applicable to both sets of regulations, the findings of the analysis of the BAT/PSES regulations reflect the potential impacts on new sources as well as on existing sources. Based on these findings, the NSPS/PSNS regulations will not create a barrier to the construction of new nonferrous metals manufacturing facilities or to the modernization of existing facilities.

CHAPTER XIV

SMALL BUSINESS ANALYSIS

XIV. SMALL BUSINESS ANALYSIS

The Regulatory Flexibility Act (RFA) of 1980 (P.L. 96-354), which amends the Administrative Procedures Act, requires Federal regulatory agencies to consider "small entities" throughout the regulatory process. The RFA requires an initial screening analysis to be performed to determine whether a substantial number of small entities will be significantly affected. If so, regulatory alternatives that eliminate or mitigate the impacts must be considered. This chapter addresses these objectives by identifying and evaluating the economic impacts of the effluent control regulations on small nonferrous metals manufacturers. As described in Chapter II, the small business analysis was developed as an integral part of the general economic impact analysis and was based on an examination of plant capacity levels and compliance costs from the regulations. Based on this analysis, EPA has determined that there will not be a significant impact on a substantial number of small entities.

For purposes of this small business analysis, the following alternative approaches were considered for defining small nonferrous metal smelting and refining operations:

- the Small Business Administration (SBA) definition;
- annual plant capacity; and
- annual plant production.

In the nonferrous metals smelting and refining industry, the SBA defines as small those firms whose employment is less than the following:

Industry Segment	Firm Employment
Primary Aluminum	2,500
Primary Copper	2,500
Primary Lead	2,500
Primary Zinc	2,500
Other Primary Metals	2,500
Secondary Producers	500

This definition is, however, inappropriate because this analysis is concerned only with plants operating as distinct units rather than with firms composed of several plants. Many of the plants are, in fact, owned by firms that produce metals not covered by this regulation. In order to avoid this confusion and to maintain consistency, annual plant capacity was used as an indicator of size. Because industry segments are assumed to operate at uniform capacity utilization levels in 1985, annual plant production yields the same classification as annual plant capacity.

In order to designate large and small plants for this small business analysis, all plants in a subcategory were first ranked by annual capacity. This ranking revealed a clear distribution between large and small plants. The following definitions of small plants are derived from this review of annual plant capacities.

Industry Segment	Annual Plant Capacity
Primary Aluminum	100,000 tons
Primary Zinc	75,000 tons
Primary Columbium/ Tantalum	750,000 pounds
Primary Tungsten	250,000 pounds
Secondary Aluminum	15,000 tons
Secondary Copper	15,000 tons
Secondary Lead	15,000 tons
Secondary Silver	25,000 troy ounces

Of the primary copper and primary lead plants subject to this regulation, none is small. The following table shows the number of small plants identified in each of the other subcategories.

Industry Subcategory	Number of Plants Incurring Costs	Number of Small Plants Incurring Costs	As a % of Total
Primary Aluminum	24	3	12.5
Primary Zinc	5	1	20.0
Primary Columbium/ Tantalum	5	1	20.0
Primary Tungsten	10	1	10.0
Secondary Aluminum	24	7	29.2
Secondary Copper	6	3	50.0
Secondary Lead	33	12	36.4
Secondary Silver	32	8	25.0

The results of the screening and plant closure analysis indicate no significant impacts in any subcategory. The only potential closures are in the secondary silver subcategory, where the analysis projects two plant closures and five production line closures. These impacts are not regarded as significant because the potential closures are very small producers of silver, and the effect on the industry is expected to be minimal. Further, silver production at many of these plants is a very limited portion of their total metal production. The same plants are expected to be covered by other effluent limitations and standards, and the actual incremental cost of compliance for the secondary silver line may be less than the amount used to project the closures identified in Chapter X.

EPA guidelines on complying with the Regulatory Flexibility Act suggest several additional ways of determining what constitutes a significant impact on a substantial number of small businesses. Evaluation pursuant to these specific criteria are not required by the Regulatory Flexibility Act, nor suggested in the legislative history. However, the Agency is examining impact criteria beyond those used in its economic analysis in order to investigate fully whether this regulation could have a significant impact on small businesses. These additional criteria for the small business analysis are:

- Annual compliance costs as a percentage of revenues for small entities are at least 10 percent higher than annual compliance costs as a percentage of revenues for large entities, or

- Annual compliance costs increase total costs of production for small entities by more than 5 percent.

Table XIV-1 presents a comparison of annual compliance costs as a percentage of revenues between small and large plants. In most instances, annual compliance costs as a percentage of revenues for small plants are more than 10 percent higher than the same ratio for large plants. However, the ratios of compliance costs to revenues for small plants are quite low, indicating minimal impact. Thus the comparison between large and small plants does not provide a true indication of the magnitude of the costs on small plants.

Annual compliance costs as a percentage of total production costs for small plants are presented in Table XIV-2. In no instance does this ratio exceed the 5 percent threshold value used here as an indicator of disproportionate effects.

TABLE XIV-1

ANNUAL COMPLIANCE COSTS AS A PERCENT OF ANNUAL REVENUES FOR LARGE AND SMALL PLANTS

(percent)

	Option A	Option B	Option C	Option E	Option G
Primary Aluminum					
Small		0.15	0.16	0.25	
Large		0.11	0.12	0.22	
Primary Zinc					
Small		0.09	0.34		
Large		0.05	0.23		
Secondary Aluminum					
Small		0.60	0.63		
Large		0.15	0.18		
Secondary Copper					
Small					0.10
Large					0.04
Secondary Lead					
Small	0.62	0.63	0.71		
Large	0.32	0.33	0.36		
Secondary Silver					
Small	1.51	1.51	2.00		
Large	0.06	0.06	0.07		
Primary Columbium/ Tantalum					
Small	0.47	0.47	0.52		
Large	1.05	1.10	1.16		
Primary Tungsten					
Small	0.68	0.68	0.92		
Large	0.62	0.62	0.67		

SOURCE: Policy Planning & Evaluation, Inc. estimates.

TABLE XIV-2

ANNUAL COMPLIANCE COSTS AS A PERCENT OF TOTAL PRODUCTION COST FOR SMALL PLANTS

(percent)

	Option A	Option B	Option C	Option E	Option G
Primary Aluminum		0.15	0.18	0.27	
Primary Zinc		0.10	0.37		
Secondary Aluminum		0.61	0.65		
Secondary Copper					0.11
Secondary Lead	0.64	0.64	0.73		
Secondary Silver	4.14	3.80	4.65		
Primary Columbium/ Tantalum	0.52	0.52	0.57		
Primary Tungsten	0.79	0.79	1.07		

SOURCE: Policy Planning & Evaluation, Inc. estimates.

CHAPTER XV

LIMITATIONS OF THE ANALYSIS

XV. LIMITATIONS OF THE ANALYSIS

This chapter discusses the major limitations of the economic impact analysis. It focuses on the limitations of data and methodology and the key assumptions and estimations made in these areas.

A. DATA LIMITATIONS

Economic theory dictates that the financial health of the major impacted industries is determined by the volume of economic activity (e.g., value of shipments), capacity utilization, and prices. Economic analyses also generally distinguish between long-run and short-run effects. Decisions regarding variable costs, capacity, and relatively small amounts of resources are generally made on short-run criteria. On the other hand, decisions regarding large investment in fixed assets are made on the basis of long-run expectations.

In the absence of complete and current plant-specific financial data, a financial profile of the various metal industry segments plants was developed based on an extensive review of trade literature and published financial reports. This financial profile is subject to the following major assumptions and limitations:

- A "normal" or average year, in terms of aggregate economic conditions and financial performance, has been used as a baseline in the economic impact analysis. Therefore, estimates of price, capacity utilization, real durable goods sales, fixed investment, and total corporate profits have been based on the assumption that economic conditions in the impact period will be an average of conditions in the 1978-1982 business cycle. In general, due to adverse conditions in 1982, this implies that macroeconomic conditions during the impact period will be better than those in 1982.

- The industry capacity is assumed to be constant at 1982 levels. Industry sources indicate that firms are not contemplating any major expansions in capacity in the near future.

- Plant-specific economic variables have been estimated using financial ratio analysis. Financial information was obtained from the annual and 10-K reports of companies engaged in the smelting and refining of nonferrous metals. For the Secondary Silver subcategory, additional financial information was obtained from the FINSTAT data base. It was assumed that the financial characteristics of each plant could be approximated by the average financial characteristics of corporate segments operating in like industries. Hence, the financial characteristics of the plants were estimated by using corporate and segment information.

- The time value of money was taken into account by basing the analysis on constant prices and constant income. Current cost information presented in annual reports was utilized in order to create financial ratios consistent with this approach.

B. METHODOLOGY LIMITATION

Two types of performance measures have been used in the economic impact analysis:

- liquidity (short-term analysis); and
- solvency (long-term analysis).

The liquidity and solvency (net present value) measures are quite rough, primarily because of the lack of data. Industry-wide information has been used to analyze the firms in both the short term and the long term, because the forecasting of firm-specific economic and institutional variables is extremely difficult. The analysis described here is not intended to be a structural specification of the profitability, liquidity, or solvency of the industries. Rather, it is designed to demonstrate that variations in the performance of the firms over time are likely to reflect general industry trends. The difference, if any, may be explained by a number of factors that were not explored in greater detail, such as capital-output ratios, or technological and market changes.

C. SENSITIVITY ANALYSIS

Sensitivity analysis is used to determine whether variations in certain key factors significantly affect the results of the economic impact study. Several parameters of the study have been varied to assess the sensitivity of the study's results. The conclusions in previous chapters are based on the best estimates for each of these paramaters. The following sections address the question of changes to the study's assumptions. The results indicate that even under these unlikely circumstances, there would not be significant adverse economic impacts in any subcategory, and that even under these conditions, the regulation is economically achievable in all subcategories.

1. Compliance Costs

A major determinant of the economic impacts is the compliance cost. Thus, the accuracy of this study's conclusions is largely related to the accuracy of the compliance costs. While the plant-specific estimates used in the impact analysis are considered to be correct, these costs have been increased 25 percent to determine the effect such an increase would have on the study's conclusions.

The screening and plant closure analysis is performed using the increased costs, and only three additional plants are identified as potential closure candidates at the selected option. Of these, one plant is in the secondary silver subcategory; one plant is in the primary copper subcategory; and one is in the secondary lead subcategory. These results are not significantly different than those obtained with the original costs.

2. Sludge Disposal Costs

The original set of cost estimates for the secondary lead subcategory are developed under the assumption that wastewater treatment sludges will be disposed of as non-hazardous wastes. While the original analysis is based on the Agency's judgment that these sludges will not be classified as hazardous, this assumption was varied to address industry's concerns that the sludges need to be treated as hazardous wastes.

In order to vary this assumption, sludge disposal costs were doubled to approximate the cost of hazardous waste disposal, which is assumed to be contract hauling to a hazardous waste disposal site.

The analysis was then conducted with the higher costs. In terms of projected plant closures, the results are not different than with the original costs; no plant closures are projected. Thus, even if the original treatment costs were underestimated due to incorrect assumptions about hazardous wastes, no significant economic impacts would be projected for the secondary lead subcatgory.

3. Prices

The prices used in the impact analysis are an average of recent prices in each subcategory. The years 1978-1982 are generally used to reflect the long-term potential of a subcategory. In two subcategories, secondary lead and secondary silver, these averages are strongly influenced by one especially high price year (1979 for lead and 1980 for silver).

In order to test the sensitivity of the analysis' conclusions to the possibly overstated prices, the highest value was eliminated from the averaging calculations. A new, lower average price was calculated and the analysis was then conducted with the lower price. In the secondary silver subcategory, one additional closure is projected. In the secondary lead subcategory, no closures are projected. Thus, even when the lower price is used, the results do not significantly vary from the original set of conclusions.

4. Sludge Disposal and Prices in Secondary Lead

For the Secondary Lead subcategory, public comments stressed the economic hardships and declining nature of the industry. Further, they addressed the uncertainty of the hazardous waste assumptions. An additional sensitivity analysis for secondary lead considered the combined effect of doubling the sludge disposal cost and using the lower price (see 2. and 3. above).

When both of these variations are combined, the closure analysis indicates one plant closure. This result is not significantly different than the original result of no closures for this subcategory. The conclusion of economic achievability is supported by these results.

5. Profit Margins for Secondary Producers

For plants producing secondary silver, lead, copper, and aluminum, industry comments suggest that plants engaged in secondary production are at somewhat of a disadvantage compared to primary producers and, as a result, have lower profit margins. For the economic analysis in the previous chapters, average financial ratios are calculated for various metal groups. Secondary lead, copper, and aluminum plants are included in a group designated "Reclamation of Metals" and secondary silver plants are included in the "Reclamation of Precious Metals" group. As a sensitivity analysis, the financial ratios for these two groups are altered by including financial conditions for more recessionary years than peak years in the averages. Using these lower financial ratios to calculate plant income and liquidation value does not result in any closures for the secondary copper, lead, and aluminum subcategories. For secondary silver, only one additional closure is projected at each treatment option. These results are not significantly different than those obtained with the original set of financial ratios. This analysis supports the conclusion of economic achievability.

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APPENDIX A

DESCRIPTION OF THE NPV TEST AND ITS SIMPLIFICATION

APPENDIX A

DESCRIPTION OF THE NPV TEST AND ITS SIMPLIFICATION

A. THE BASIC NPV TEST

The net present value test is based on the assumption that a company will continue to operate a plant if the cash flow from future operations is expected to exceed its current liquidation value. This assumption can be written mathematically as follows:

$$\left[\sum_{t=1}^{T} U_t \left(\frac{1}{1+r}\right)^t\right] + L_T \left(\frac{1}{1+r}\right)^T \geq L_o \qquad (1)$$

where: U_t = cash flow in year t

L_o = current liquidation value

L_T = terminal liquidation value of the plant at the end of a planning horizon of T years

r = cost of capital.

In order to use this formula, in this form, and in nominal dollars, forecasts of the terminal liquidation value (L_T) and income in every year during the planning period (U_t) have to be made. However, the need to make the forecasts can be avoided by using a simplified NPV formula, which is discussed in the following section.

B. SIMPLIFICATION OF THE NPV TEST

Equation (1) can be simplified by making the following three assumptions:

- the equation considers real dollars, that is, the income, the liquidation value, and the rate of return are all expressed in real terms (see Section C for definitions);
- $U_t = U_k = \overline{U}$, that is, real cash flows over the planning horizon are constant (or income in any given year is equal to the income in any other year); and
- the current liquidation value is equal to the terminal liquidation value, that is, $\overline{L}_T = \overline{L}_o$.

Based on these assumptions, equation (1) can be rewritten as:

$$\sum_{t=1}^{T} \bar{U}\left(\frac{1}{(1+\bar{r})}\right)^{t} + \left(\frac{1}{(1+\bar{r})}\right)^{T} \bar{L}_o \geq \bar{L}_o \qquad (2)$$

This expression can be simplified in the following manner. Let

$$k = \frac{1}{(1+\bar{r})},$$

Equation (2) may be written:

$$\left[\bar{U} \sum_{t=1}^{T} k^{t}\right] + k^{T} \bar{L}_o \geq \bar{L}_o$$

Redefining the first bracket, and combining the two $\bar{L}_o$ terms:

$$\bar{U}\left[\sum_{t=1}^{\infty} k^{t} - \sum_{t=T+1}^{\infty} k^{t}\right] \geq \bar{L}_o(1-k^{T})$$

Using the expression for the sum of a geometric series,

$$\bar{U}\left[\frac{k}{(1-k)} - \frac{k^{T+1}}{(1-k)}\right] = \bar{U}\left[\frac{k}{(1-\text{[illegible]}}\right]\text{[illegible]}-k^{T}) \geq \bar{L}_o(1-k^{T});$$

$$\bar{U}\frac{k}{(1-k)} \geq \bar{L}_o;$$

$$\frac{\bar{U}}{\bar{r}} \geq \bar{L}_o;$$

$$\frac{\bar{U}}{\bar{L}_o} \geq \bar{r}. \qquad (3)$$

Where: $\bar{r}$ = real after-tax cost of capital

$\bar{U}$ = real cash flow

$\bar{L}_o$ = current liquidation value in real terms.

These terms are defined in more detail in Section C below.

Equation (3) states that if the rate of return on the liquidation value ($\bar{U}/\bar{L}_o$) is greater than or equal to the real after-tax rate of return on assets, then the plant will continue in operation. Equation (3) is the same test as expressed in Equation (1), but is simpler to use. It does not require the forecasts of income and liquidation value.

The real rate of return on assets can be shown to be equal to the cost of capital. This relationship is explained in Section C. Thus, the methodology employed for the NPV test uses the rate of return on assets as a proxy for the cost of capital.

C. DISCUSSION OF REAL CASH FLOWS, COST OF CAPITAL, AND LIQUIDATION VALUE

1. Real Cash Flows

The difference between nominal cash flows and real cash flows is in the calculation of depreciation. While depreciation is calculated at book value for nominal cash flows, it is calculated at replacement value for real cash flows. In accordance with the definition of nominal cash flows used in Section II-G, real cash flows are as follows:

$$\text{Real Cash Flows } (\bar{U}) = \text{Revenue} - \begin{array}{c}\text{All Operating Expenses}\\ \text{Including Depreciation}\\ \text{at Replacement Value}\end{array} - \text{Taxes}$$

Normally, depreciation is not taken into account in calculating cash flows; however, it is included in the cash flow definitions. This inclusion means that a plant continuously maintains or replaces the capital equipment. The cost of maintaining and/or replacing equipment is equal to the depreciation. In order to calculate real cash flow, depreciation is taken at replacement value, not book value. Using this approach implies that the value of a plant's equipment remains constant, and therefore, the current liquidation value (L_o) is equal to the terminal liquidation value (L_T).

2. Real Cost of Capital

This report uses rate of return on assets as a substitute for cost of capital. However, the cost of capital can be shown to be equivalent to the rate of return on assets as follows. According to the Modigliani-Miller model (M-M model) the value of a leveraged firm is calculated by the formula (Miller, 1977):

$$V = \frac{X(1 - t)}{K_u} + (D)(t) \qquad (1)$$

Where: V = value of the firm

X = operating income before taxes

t = tax rate

K_u = cost of capital of an unleveraged firm

D = debt.

The cost of capital of a leveraged firm in the M-M model is given by the formula:

$$K_L = K_u(1 - t\frac{D}{V}) \qquad (2)$$

Where: K_L = cost of capital of a leveraged firm. By solving Equation (2) for K_u, we get

$$K_u = \frac{K_L}{(1 - t\frac{D}{V})} \qquad (3)$$

Using this value of K_u in equation (1), and simplifying, we get:

$$V = \frac{X(1 - t)(1 - t\frac{D}{V})}{K_L} + (D)(t) \qquad (4)$$

Dividing the whole equation by V, we get:

$$1 = \frac{X(1 - t)(1 - t\frac{D}{V})}{VK_L} + \frac{(D)(t)}{V}$$

Therefore,

$$1 - \frac{(D)(t)}{V} = \frac{X(1 - t)(1 - t\frac{D}{V})}{VK_L}$$

$$1 = \frac{X(1 - t)}{VK_L}$$

$$VK_L = x(1 - t)$$

or

$$K_L = \frac{X(1 - t)}{V} \qquad (5)$$

Since the value of the firm = Equity + Debt = Assets, Equation (5) can be rewritten as:

$$K_L = \frac{X(1 - t)}{A}$$

Where: A = assets of the firm.

The equation above says that cost of capital (K_L) is equal to the after-tax rate of return on assets. The return on assets for a firm or a group of firms can be calculated by using information from financial statements. For the purposes of this report the real rate of return is calculated as follows:

$$\text{The real rate of return } (\bar{r}) = \frac{\text{real cash flows } (\bar{U})}{\text{total assets at replacement value}}$$

3. Real Liquidation Value

When a plant is liquidated (that is, when its assets are sold), its owner can expect to get only a portion of the value of the assets. The assets can be valued at their replacement value or at book value. If they are calculated at replacement value and a fraction of the replacement value is taken in calculating the liquidation value, then the liquidation value is called the real liquidation value.

APPENDIX B

IMPLEMENTATION OF THE NPV TEST

APPENDIX B

IMPLEMENTATION OF THE NPV TEST

A. PRIMARY PROBLEM IN IMPLEMENTING THE TEST

The NPV formula reduces to the following equation:

$$\frac{\overline{U}}{\overline{L}_o} \geq \overline{r}.$$

If there were no limitations to the availability of plant-specific financial data, the values of these three variables could be calculated for each plant. The data collected in the Agency's survey of the industry, however, is limited with respect to current financial and cost information. Information on income, depreciation, capital expenditures, cost of capital and future sales are needed to carry out the NPV test; hence, it must be estimated for each plant from publicly available information.

The task of estimating the data for each plant is simplified by:

- classifying the nonferrous metals industry into eight groups;
- estimating the values of ratios such as: operating income/sales, operating income/assets, current assets/sales, non-current assets/sales, and capital expenditure/sales for each of the eight groups; and
- classifying a plant into one of the eight groups, and applying the ratios associated with the group to the plant.

B. ORGANIZATION OF THIS APPENDIX

Section C below describes the method used to classify the industry into eight groups, defines the groups, and describes the applicability to the specific metals covered in this report. Section D discusses the procedure used to calculate group ratios. Section E presents the method used to estimate sales of each plant, and Section F discusses the methods used to estimate operating income, current assets, fixed assets, capital expenditures, and the liquidation value of each plant. Section G summarizes the earlier sections with an overview of the NPV test.

C. DEVELOPMENT OF GROUPS AND APPLICATION TO METALS

1. Definition of Groups

The eight groups were formed by using the following steps:

- The annual and 10K reports of 30 companies engaged in the production of nonferrous metals were obtained.

- Most annual and 10K reports provide financial information pertaining to major lines of business (business segment information). The 30 annual reports contained data on 40 business segments. (Some companies had more than one line of nonferrous metal business.)

- These 40 business segments were classified into eight relatively homogenous groups by examining qualitative descriptions of business segments, and by calculating average group ratios and evaluating the differences among groups.

Data for the years 1980, 1981, and 1982 were used to establish the eight groups. These groups, representing similar business and financial characteristics, are as follows:

- Group 1. Smelting and Refining of Primary Base Metals -- This group includes the mining, smelting, and refining of primary base metals, such as copper, lead, zinc, and aluminum. Many large-scale companies such as Asarco, Alcoa, and Amax are primarily engaged in the production of such metals.

- Group 2. Smelting and Refining of Precious Metals -- Four companies have concentrated their operational activities in the mining, smelting, and refining of precious metals such as gold, silver, and platinum.

- Group 3. Smelting and Refining of Other Nonferrous Metals (not included in Groups I and II) -- About six companies are engaged in the mining, smelting, and refining of other metals, such as lithium, molybdenum, columbium, tungsten, zirconium, beryllium, nickel, cobalt, and chrome. Such metals generally have anti-wear, anti-corrosion characteristics. They also enhance the toughness and strength of ferrous-based alloys.

- Group 4. Reclamation of Precious and Semi-Precious Metals -- Reclamation of such metals from scrap, jewelry, and electronic components is being undertaken on a large scale by various companies such as Handy and Harman, Refinement Corporation, and Diversified Industries, Inc. The value of shipments of reclaimed metals is a significant portion of shipments for these companies.

- Group 5. Smelting and Refining for Producing Alloys -- Mining, smelting, and refining for the purpose of producing alloys is an important segment for many companies, including Foote-Mineral Co., Cabot Corporation, and Hanna Mining Co. These products include ferro-alloys, tantalum alloys, columbium alloys, and nickel alloys. Reclamation of alloys from metal scrap is also included in this segment because it constitutes a significant part of business operations for these companies.

- Group 6. Reclamation of Base and Other Nonferrous Metals -- In addition to producing metals such as copper, aluminum, and zinc from their respective ores, companies may also reclaim these metals from scrap, junked automobiles and electronic appliances. This group covers reclamation activities for these and other nonferrous metals.

- Group 7. Production of Metal Products, Alloys, and Metal Powders -- The combination of metal products, alloys, and metal powders is considered one segment. It does not involve any mining or recycling. Companies engaged in such production purchase raw materials to manufacture such items.

- Group 8. Production of Rare-Earth Metals -- Rare-earth metals have special characteristics of their own. They improve many common items; for example, some help polish glass, decolor it, or tint it, and others filter out or absorb light rays. Examples of such metals are mischmetal, cerium, lanthanum, and didymium. Because of these special characteristics, the production of rare-earth metals has been taken as a separate segment.

2. Application of Groups to Subcategories

Ten metal subcategories are included in the economic analysis. The plants in these subcategories are evaluated with financial ratios from the groups defined above. Assigning the subcategories to specific groups is straightforward. The following list identifies the assignments.

Subcategory	Group Used for Financial Ratios
Primary Aluminum	Group 1: Smelting and Refining of Primary Base Metals
Primary Copper	Group 1: Smelting and Refining of Primary Base Metals
Primary Lead	Group 1: Smelting and Refining of Primary Base Metals
Primary Zinc	Group 1: Smelting and Refining of Primary Base Metals
Secondary Aluminum	Group 6: Reclamation of Base and Other Nonferrous Metals
Secondary Copper	Group 6: Reclamation of Base and Other Nonferrous Metals
Secondary Lead	Group 6: Reclamation of Base and Other Nonferrous Metals
Secondary Silver	Group 4: Reclamation of Precious and Semi-Precious Metals
Primary Columbium/Tantalum	Group 5: Smelting and Refining for Producing Alloys
Primary Tungsten	Group 7: Production of Metal Products, Alloys, and Metal Powders

D. PROCEDURE FOR CALCULATING GROUP RATIOS

Each of the eight groups defined above is comprised of several business segments. Group financial ratios are calculated as follows:

- calculate financial ratios for each segment within the group over several years; and
- average segment ratios over all segments and all years.

The details of the calculations for each group ratio are presented below. The results of these calculations (the group ratios) are shown in Table B-1, at the end of this Appendix.

1. Calculation of Operating Income/Sales

$$\frac{\bar{U}_g}{S_g} = \frac{\text{real cash flow of group g}}{\text{sales of group g}}$$

$$\frac{\bar{U}_g}{S_g} = \frac{1}{T}\sum_{t=1}^{T}\frac{1}{M}\sum_{m=1}^{M}\frac{\bar{U}_{m_g,t}}{S_{m_g},t}$$

Where: $\bar{U}_{m_g,t}$ = real cash flow of segment m in group g in year t (calculated from business segment information of annual reports).

$S_{m_g,t}$ = sales of segment m in group g in year t (given in business segment information of annual reports).

M = number of segments in group g.

t = 1978, 1979, 1980, 1981, 1982.

2. Operating Income/Assets (Real Cost of Capital)

$$\bar{r}_g = \frac{\bar{U}_g}{A(adj)_g} = \frac{\text{real cash flow of group g}}{\text{adjusted assets of group g}}$$

$$\bar{r}_g = \frac{\bar{U}_g}{A(adj)_g} = \frac{1}{T}\sum_{t=1}^{T}\frac{1}{M}\sum_{M=1}^{M}\frac{\bar{U}_{m_g,t}}{A(adj)_{m_g,t}}$$

Where: $A(adj)_{m_g,t}$ = adjusted value of assets of segment m in group g in year t.

$$A(adj)_{m_g,t} = \left(A_{m_g,t}\right)\cdot(1+x)$$

Where: $(1+x) = \frac{\text{current costs}}{\text{historical costs}} = \frac{1}{h}\sum_{1}^{h}\frac{\text{depreciation at replacement value in 1982}}{\text{depreciation at book value in 1982}}$

h = Number of companies in the data base.

$A_{m_g,t}$ is obtained from business segment information contained in annual reports.

3. Current Assets/Sales

$$\frac{(CA)_g}{S_g} = \frac{\text{current assets of group } g}{\text{sales of group } g}$$

$$\frac{(CA)_g}{S_g} = \frac{1}{T} \sum_{t=1}^{T} \frac{1}{M} \sum_{m=1}^{M} \frac{(CA)_{m_g,t}}{S_{m_g,t}}$$

Where: $(CA)_{m_g,t}$ = current assets of segment m in group g in year t.

The business segment information contained in corporate annual reports does not give any information on current assets of the segments. Therefore, current assets of the segments have been estimated based on the characteristics of the company to which they belong.

$$(CA)_{m_g,t} = \left[\frac{(CA)_{c_g,t}}{S_{c_g,t}}\right] S_{m_g,t}$$

Where: $(CA)_{c_g,t}$ = current assets of the company c (to which the segment m belongs) in group g in year t.

$S_{c_g,t}$ = sales of company c (to which the segment m belongs) in group g in year t.

$S_{m_g,t}$ = sales of segment m of company c in group g in year t.

4. Non-Current Assets/Sales

$$\frac{(BV)_g}{S_g} = \frac{\text{book value of plant and equipment of group } g}{\text{sales of group } g}$$

$$\frac{(BV)_g}{S_g} = \frac{1}{T} \sum_{t=1}^{T} \frac{1}{M} \sum_{M=1}^{M} \frac{(BV)_{m_g,t}}{S_{m_g,t}}$$

Where: $(BV)_{m_g,t}$ = book value of segment m in group g in year t.

The business segment information contained in annual reports of companies does not give information on book values of plant and equipment of segments. Hence, they have been estimated by the same method used for estimating current assets of segments.

$$(BV)_{m_g,t} = \left[\frac{(BV)_{c_g,t}}{S_{c_g,t}}\right] S_{m_g,t}$$

Where: $(BV)_{c_g,t}$ = book value of the company c (to which the segment m belongs) in group g in year t.

5. Capital Expenditure/Sales

$$\frac{(CE)_g}{S_g} = \frac{\text{capital expenditures of group } g}{\text{Sales of group } g}$$

$$\frac{(CE)_g}{S_g} = \frac{1}{T} \sum_{t=1}^{T} \frac{1}{M} \sum_{M=1}^{M} \frac{(CE)_{m_g,t}}{S_{m_g,t}}$$

Where: $(CE)_{m_g,t}$ = capital expenditures of segment m in group g in year t. (Given in business segment information of annual reports of companies.)

E. ESTIMATION OF ANNUAL REVENUES (SALES) OF EACH PLANT

$S_{i_g,D}$ = sales of plant i in group g in the year D (1985)

$$S_{i_g,D} = \left[C_{i_{1982}} \times (CU)_i \right] P_I$$

Where: $C_{i_{1982}}$ = Capacity of plant i in 1982 (assumed to be the same in 1985).

$(CU)_i$ = Average capacity utilization of plant i belonging to industry I between 1978 and 1982.

= Average capacity utilization of industry I between 1978 and 1982.

P_I = Average real (inflation adjusted) price of metal in industry I under between 1978 and 1982.

F. ESTIMATION OF PLANT LEVEL OPERATING INCOME, CURRENT ASSETS, PLANT AND EQUIPMENT, CAPITAL EXPENDITURES, AND LIQUIDATION VALUE

It is assumed that each plant possesses the characteristics of the group in which it falls. Hence, group ratios are used to estimate plant-level variables. The values of most of these variables are calculated by multiplying a group ratio (as defined in Section D above) by the plant's sales (Section E above).

1. Calculation of Operating Income of Plants

$\bar{U}_{i_g,D}$ = real cash flow of plant i in group g in the year D.

$$\bar{U}_{i_g,D} = S_{i_g,D} \times \frac{\bar{U}_g}{S_g}$$

2. Calculation of Current Assets of Plants

$(CA)_{i_g,D}$ = current assets of plant i in group g in the year D.

$$(CA)_{i_g,D} = S_{i_g,D} \times \left[\frac{(CA)_g}{S_g}\right]$$

3. Calculation of Plant and Equipment of Plants

$(BVadj)_{i_g,D}$ = adjusted book value of plant and equipment of plant i in group g in the year D.

$$(BVadj)_{i_g,D} = (BV)_{i_g,D} \times (1+x)$$

$$\text{where } (1+x) = \frac{\text{current costs}}{\text{historical costs}}$$

$$(BV)_{i_g,D} = S_{i_g,D} \frac{(BV)_g}{S_g}$$

4. Calculation of Capital Expenditures of Plants

$(CE)_{i_g,D}$ = capital expenditures of plant i in group g in the period D.

$$(CE)_{i_g,D} = S_{i_g,D} \times \left[\frac{(CE)_g}{S_g}\right]$$

5. Calculation of Liquidation Value

$L_{o_{i_g,D}}$ = real liquidation value of plant i in group g in period D.

Under the assumption that plant and equipment have no scrap value except as a tax write-off (a common practice in the industry), the liquidation value is calculated as follows:

$$\bar{L}_{o_{i_g},D} = 0.7(CA)_{i_g,D} + t\ (BV)_{i_g,D}$$

Where: t = tax rate.

Only a portion of the value for current assets is included in the liquidation value because only a certain amount can be recovered when the plant is liquidated. Financial literature suggests this portion to be approximately 70 percent of current assets.

Neither short-term nor long-term liabilities are taken into account while calculating the liquidation value of plants, because they do not affect the plant closure decisions. Whether the plant is closed or is kept operating, liabilities will have to be paid, and so they are not crucial decision factors in plant-closure analysis.

G. IMPLEMENTATION OF NPV TEST

The general form of the NPV test is

$$\frac{\bar{U}}{\bar{L}_o} \geq \bar{r}$$

In order to implement the NPV test, the annual compliance cost must be subtracted from the real cash flow of the plant. Thus, the NPV test for each plant can be written as:

$$\frac{\bar{U}_{i_g,D(adj)}}{\bar{L}_{o_{i_g},D}} \geq \bar{r}_g$$

where

$\bar{U}_{i_g,D}(adj) = \bar{U}_{i_g,D} - (\text{Total Annual Cost})_i$

$\bar{L}_{o_{i_g},D}$ = liquidation value of plant i (defined above in Section F.5)

$\bar{r}_g$ = real cost of capital for group g (defined above in Section D.2)

The procedure for calculating total annual cost is explained in Appendix C.

TABLE B-1

VALUES FOR GROUP RATIOS

Group No.	Real Cost of Capital $(\bar{r})$	Operating Income to Sales (U/S)	Capital Expenditure to Sales (CE/S)	Non-Current Assets to Sales (BV/S)	Current Assets to Sales (CA/S)
1	0.1014	0.0740	0.1188	0.5430	0.4187
2	0.2562	0.2993	0.1036	0.4521	0.5265
3	0.1725	0.2064	0.1415	0.4781	0.4373
4	0.2069	0.0936	0.0100	0.0717	0.3988
5	0.1669	0.0848	0.0452	0.2075	0.3510
6[a]	0.0404	0.0274	0.0328	0.1644	0.3217
7	0.1466	0.1430	0.0906	0.2881	0.4507
8	0.1187	0.0884	0.3890	0.3396	0.4362

[a] The following ratios were calculated from FINSTAT data for small secondary silver plants: $\bar{r} = 0.131$; U/S = 0.022; BV/S = 0.023; CA/S = 0.133.

APPENDIX C

CALCULATION OF TOTAL ANNUAL COSTS FOR THE TWO CLOSURE ANALYSIS TESTS

APPENDIX C

CALCULATION OF TOTAL ANNUAL COSTS FOR THE TWO CLOSURE ANALYSIS TESTS

Both the Net Present Value test (NPV test) and the liquidity test deduct the incremental compliance costs from revenues (operating income). While the NPV test judges the firm from the long-term point of view, the liquidity test appraises the short-term viability of the firm. The incurrence of pollution control expenditures, therefore, calls for an adjustment to the real cash flows discussed in Appendix A. The additional costs result in annual cash outflows as a result of increased operating costs, depreciation, maintenance expenditures, and payments for the initial capital outlay. However, these costs also result in some tax benefits, as taxable income is determined after the deduction of both operating and depreciation expenditures. The firms also benefit from the Investment Tax Credit (ITC). For purposes of estimating the pollution control costs for the two tests, all tax benefits must be considered.

A. CALCULATION OF TAX BENEFITS DUE TO INCREASED DEPRECIATION

Since depreciation is an allowable expense for tax purposes, it has the effect of reducing taxes. If the tax rate is assumed to be t and depreciation is D, taxes decrease by (t)(D) every year. The tax savings are in nominal dollars; hence, the present value of the tax benefits must be calculated by discounting the nominal tax savings by the nominal rate of return.

The depreciation tax benefit in year k = $t(D_k)$

Where: $D_k = d_k \times 0.95P$[1]

d_k = depreciation rate in year k

P = capital cost to the plant.

The present value of the depreciation tax shelter =

$$\sum_{k=1}^{K} \frac{t(D_k)}{\left[(1+\bar{r})\ (1+g)\right]^k}$$

---

[1] In accordance with the terms of the Tax Equity and Fiscal Responsibility Act of 1982, only 95% of the capital costs can be depreciated. Thus, the amount P, which is the initial capital cost, is adjusted to 95 percent of its value.

Where: $\bar{r}$ = real cost of capital (as defined in Appendix B, Section D.2; this value varies by group)

g = inflation rate (assumed to be 6 percent)

K = taxable life of the asset.

The capital expenditures required to install the necessary treatment equipment have been depreciated over the taxable life of five years. In accordance with the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA), capital equipment can be depreciated as follows.

1) 15% of the depreciable assets (95% of P) equals the depreciation in the first year.

2) The remaining portion of the asset (85%) is depreciated on a straight-line basis over four years. In this study, the depreciation rates are taken to be 22% for the second year and 21% for each of the last three years.

B. CALCULATION OF EFFECTIVE CAPITAL COST (NPV TEST)

The effective capital cost is calculated after the deduction of the following items from the capital costs of pollution control equipment:

1) Investment tax credit (ITC), which in accordance with TEFRA equals 10% of capital costs;

2) Present value of depreciation and interest tax shelters.

$$\sum_{k=1}^{5} tD_k \times \frac{1}{[(1+\bar{r})(1+g)]^k}$$

Therefore,

$$\text{Effective Capital Cost} = \left\{P - 0.1P - \sum_{k=1}^{5} tD_k \times \frac{1}{[(1+\bar{r})(1+g)]^k}\right\}$$

C. CALCULATION OF ANNUALIZED CAPITAL COSTS (NPV TEST)

The effective capital expenditures are amortized over the useful lifetime of the asset to obtain annualized capital costs as follows:

$$\text{The annualized capital costs (ACC)} = \left\{0.9P - \sum_{k=1}^{5} tD_k \times \frac{1}{[(1+\bar{r})(1+g)]^k}\right\} \times \frac{\bar{r}(1+\bar{r})^n}{(1+\bar{r})^n - 1}$$

where n = 10 = the assumed lifetime of the equipment.

D. CALCULATION OF TOTAL ANNUAL COSTS (NPV TEST)

The annual pollution control expenditures (APC_p) are calculated as follows:

$$APC_p = ACC + (1-t)AAC$$

Where: ACC = annualized capital cost (see Section C)

AAC = annual operating costs. The term (1-t) takes into account the tax effect of increased expenses.

E. THE NPV TEST

The NPV test, which now takes into account the pollution control expenditures, can be stated as follows:

If

$$\frac{\bar{U} - APC_p}{C_o} \geq \bar{r}$$

Then, a plant will continue in operation.

F. CALCULATION OF ANNUAL POLLUTION CONTROL EXPENDITURES (LIQUIDITY TEST)

The liquidity test is designed to measure the short-term solvency of the firm. The basic premise of this analysis is that a plant will close if pollution control expenditures cause negative cash flows in the foreseeable future. The cash flows are defined as earnings after all operating expenses (including depreciation), interest, and taxes.

The effective capital cost is, therefore, amortized over a shorter period of five years. The annualized capital cost (ACC_q) in this case is

$$ACC_q = \left\{0.9P - \sum_{k=1}^{5} tD_k \times \frac{1}{[(1+\bar{r})(1+g)]^k}\right\} \frac{\bar{r}(1+\bar{r})^5}{(1+\bar{r})^5 - 1}$$

Total annual pollution control expenditures (APC_q) in the case of the liquidity test are, therefore, greater than in the case of the NPV test.

G. THE LIQUIDITY TEST

The liquidity test can now be stated as follows:

If

$$U - APC_q \leq 0$$

Then, the plant will close.

APPENDIX D

PROCEDURE FOR CALCULATING INDUSTRY-WIDE IMPACTS

APPENDIX D

PROCEDURE FOR CALCULATING INDUSTRY-WIDE IMPACTS

This appendix briefly details the procedures followed in computing certain ratios used to analyze industry-wide impacts. These impacts concern: (1) changes in production costs; (2) price changes; (3) changes in return on investment; and (4) effects on capital expenditures.

A. CHANGES IN PRODUCTION COSTS

$$\text{Changes in production costs} = \frac{\sum_{i=1}^{n} (APC_i)}{\sum_{i=1}^{n} (S_i - \bar{U}_i)}$$

Where: APC_i = annual pollution control expenditures of plant i

S_i = annual sales of plant i

$\bar{U}_i$ = real income of plant i

n = number of plants in subcategory

B. PRICE CHANGES

$$\text{Changes in price} = \frac{\sum_{i=1}^{n} APC_i}{\sum_{i=1}^{n} S_i}$$

Where: APC_i = annual pollution control expenditures of plant i

S_i = annual sales of plant i

n = number of plants in subcategory

C. CHANGES IN RETURN ON INVESTMENT

$$\text{Changes in return on investment} = \frac{(\bar{r}' - \bar{r})}{\bar{r}}$$

Where: $\bar{r}$ = precompliance real rate of return for each subcategory, as defined in Appendix A.

$\bar{r}'$ = postcompliance real rate of return for each subcategory

$\bar{r}'$ is computed as follows:

$$\bar{r}' = \frac{\sum_{i=1}^{n} (\bar{U}_i - APC_i)}{\sum_{i=1}^{n} (A_i + CC_i)}$$

Where: $\bar{U}_i$ = real income of plant i

APC_i = annual pollution control expenditures of plant i

A_i = assets of plant i, which equal $\bar{U}_i/\bar{r}$

CC_i = pollution control capital costs of plant i

n = number of plants in subcategory

D. EFFECTS ON CAPITAL EXPENDITURES

$$\text{Effects on capital expenditures} = \frac{\sum_{i=1}^{n} CC_i}{\sum_{i=1}^{n} CE_i}$$

Where: CC_i = pollution control capital costs of plant i

CE_i = estimated capital expenditure budget of plant i

n = number of plants in subcategory